The Chernobyl Story [Updated & Expanded]
By rspc

The Chernobyl Story [Updated & Expanded]

rspc
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51

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pripyat-city.ru ©

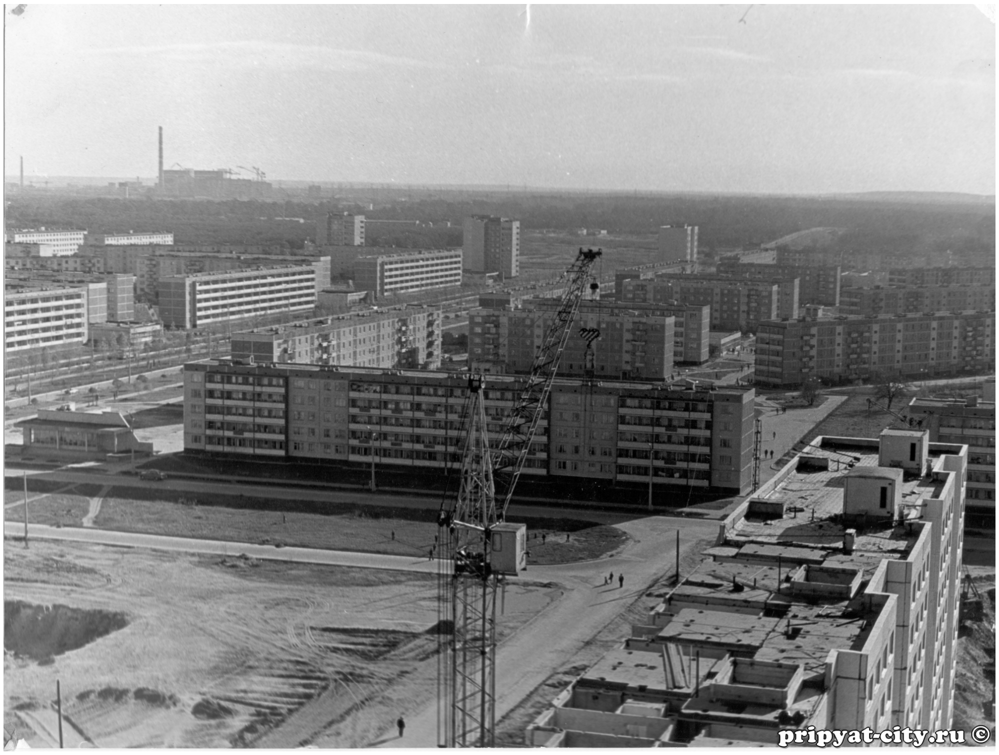
The Chernobyl Nuclear Power Plant, officially known as the V. I. Lenin Atomic Power Plant during the Soviet era, began construction in 1970 in a remote region near Ukraine's swamp-filled northern border, 15 kilometers northwest of the small town of Chernobyl. The desolate location was chosen because of its relative proximity to (yet safe distance from) Ukraine's capital, a ready water supply - the River Pripyat - and the existing railway line running from Ovruc in the west to Chernigov in the east.

pripyat-city.ru ©

It was the first nuclear power station ever to be built in the country, and was considered to be the best and most reliable of the Soviet Union's nuclear facilities.

ОБЫЛЬСКАЯ АЭС им. В. И. ЛЕНИНА РАБОТ
ВСЕ, ЧТО ПАРТИЯ НАМЕТИЛА, – ВЫПОЛНИМ С Ч

To oversee the titanic operation, 35-year-old turbine expert and loyal communist Viktor Bryukhanov was plucked from his position as Deputy Chief Engineer at the Slavyanskaya thermal power station in eastern Ukraine, and appointed as Chernobyl's Director. He's second from the left.



Concurrent to the construction of the power station, the Soviet Union's ninth Atomograd - Russian for 'atomic city' - named Pripyat was being erected 3 kilometers away, for the express purpose of housing the ambitious station's 50,000 operators, builders, support staff and their families.

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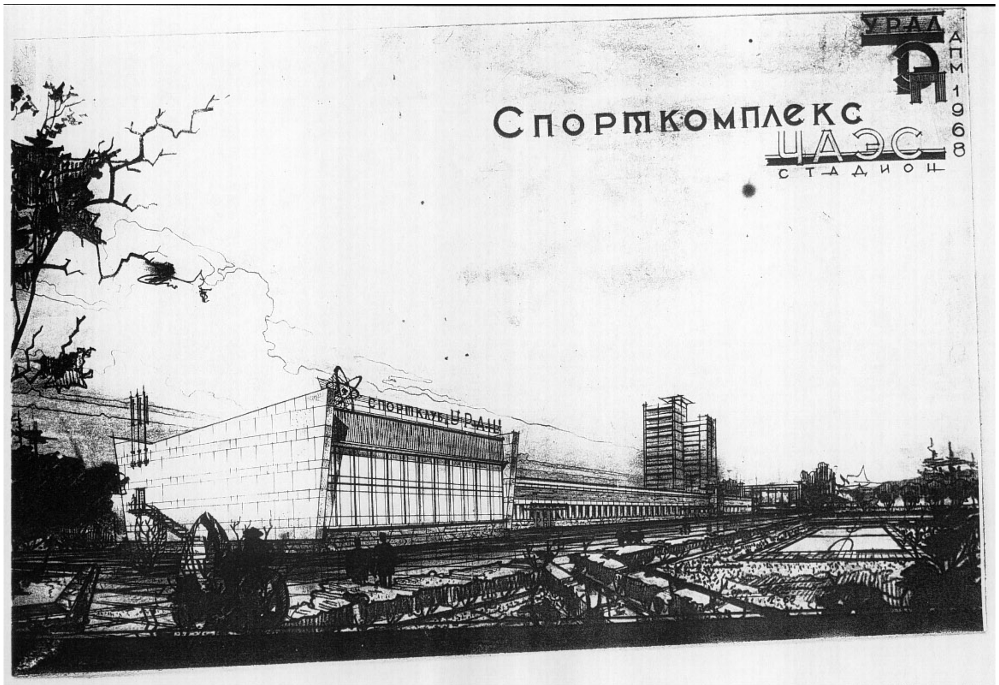
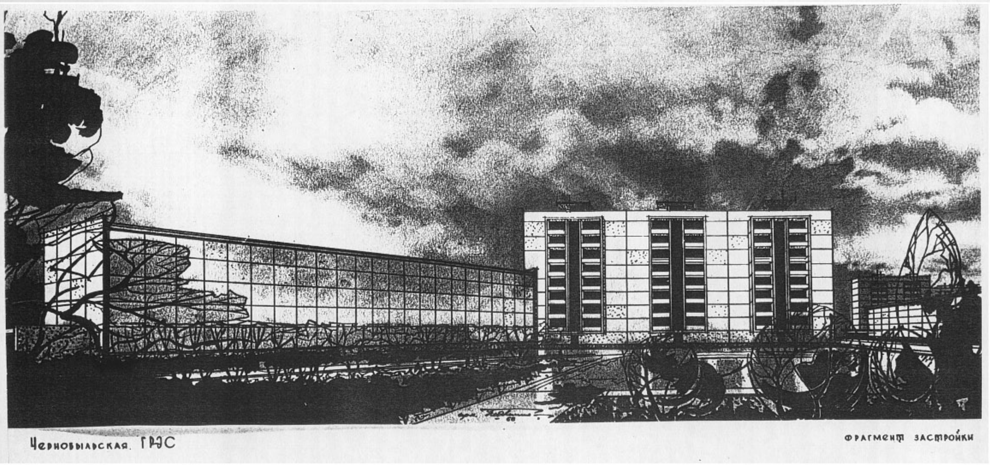

УРАЛ
АПМ 1968
Спорткомплекс
ЦАЭС
стадион
Спортклуб Урал


Чернобыльская ГРЭС
Фрагмент застройки

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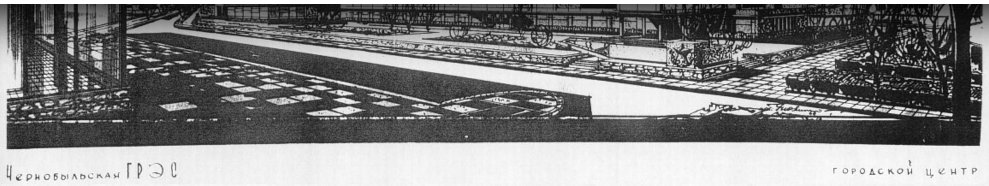
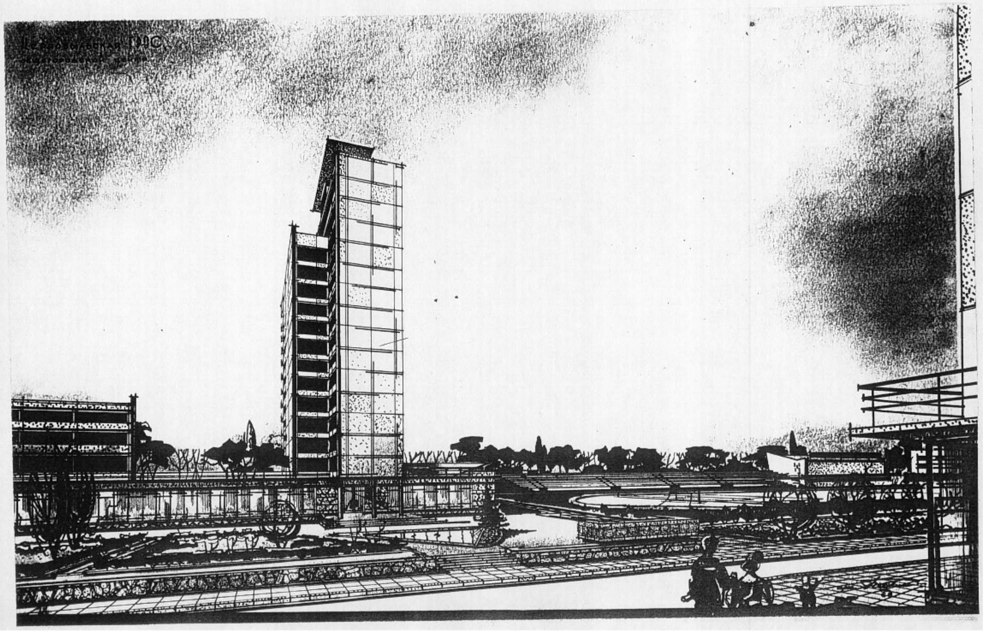
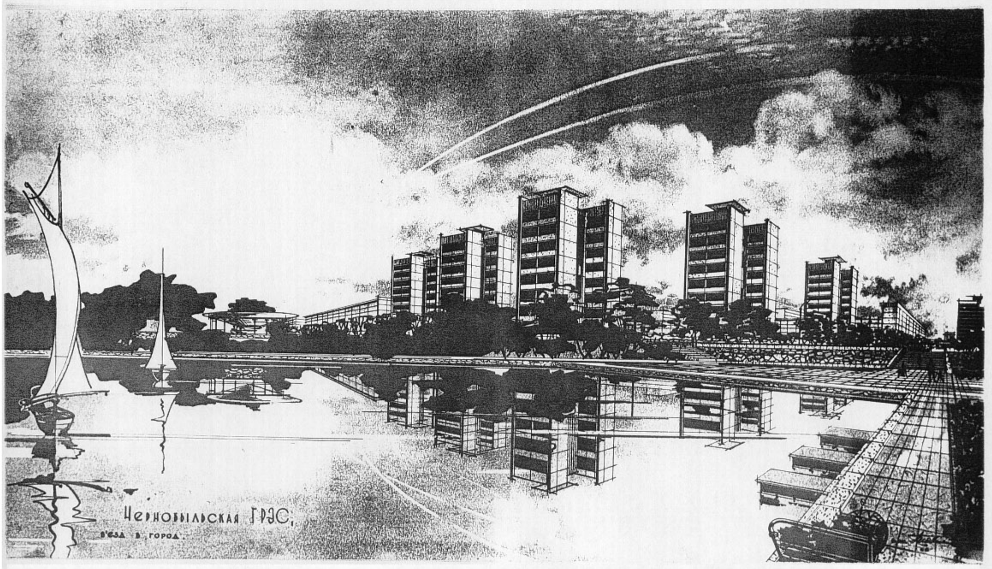
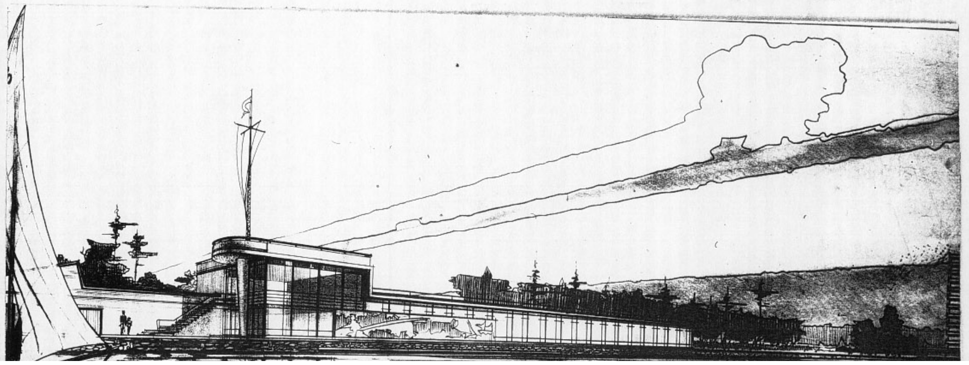

Чернобыльская ГРЭС
городской центр


Чернобыльская ГРЭС,


Чернобыльская ГРЭС,
в'езд в город.



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These original architect's drawings portray Pripyat as a kind of utopia.

pripyat-city.ru ©

challenging, so many of Chernobyl's workers came straight from college/university. As a result, Pripyat was one of the ‘youngest’ cities in the Soviet Union, with an average age of only 26.

СЛАВА ТРУДУ
pripyat-city.ru ©

Because Pripyat was new and carried with it the prestige of a nuclear power station, it was afforded many modern luxuries other Soviet cities sometimes did without.

6
pripyat-city.ru ©

It had all the facilities you would expect of a modest-sized city. In addition to a hospital and its nearby clinics, there were 15 kindergartens, 5 schools, a vocational school/college and a school of music and the arts for the children, with 1 expansive park and 35 smaller playgrounds for them to play in.

СЛАВА КПСС
МИРУ МИР
ЕДИНСТВО ПАРТИИ И НАРОДА НЕРУШИМО
ДОСРОЧНО ВВЕДЕМ В ДЕЙСТВИЕ ЭНЕРГОБЛОКИ ЧАЭС
ЭНЕРГЕТИКИ ЧЕРНОБЫЛЬСКОЙ АЭС ИМ. В. И. ЛЕНИНА ОБЯЗАЛ СЬ ПЛАН
РЕАЛИЗАЦИИ ПРОДУКЦИИ ВЫПОЛНИТЬ К 22 ДЕКАБР 1983 ГОД
pripyat-city.ru ©

Further entertainment was found at any of the city’s 10 gyms, 3 swimming pools, 10 shooting ranges, 2 stadiums, 4 libraries and a cinema, or by reading Pripyat’s own newspaper.

Retail came in the form of 25 shops including a bookshop, a supermarket and various smaller food stores, a sports shop, a shop selling TVs, radios and other electronics, and a large shopping centre on the city’s central square.

ПОЛИТБЮРО ЦК КПСС

The Chernobyl Story [Updated & Expanded]

By rspc

PRIPYAT·CITY·RU
ВСЕ О ГОРОДЕ ПРИПЯТЬ

For down-time there were 27 canteens, cafés and restaurants distributed throughout the city. All in all, it was a very nice place to live compared to many other locations in the Soviet Union.

pripyat.com
ПРИПЯТЬ
1970

A wedding couple in front of Pripyat's city sign.

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pripyat-city.ru ©

Children playing in main square.

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СЛАВА ЛЕНІНУ
ХОЧЕШЬ ЕСТЬ КАЛАЧИ,
ТАК ДОЛГО НЕ СИДИ
НА ПЕЧИ!

The Chernobyl Story [Updated & Expanded]

By rspc

This must have been taken quite close to the accident, as the ferris wheel in the background wasn't officially due to open until 2 days after the explosion.

Looks familiar...

The Chernobyl Story [Updated & Expanded]

By rspc

The Palace of Culture, where community events were held, is seen here on the left, with the hotel in the centre.

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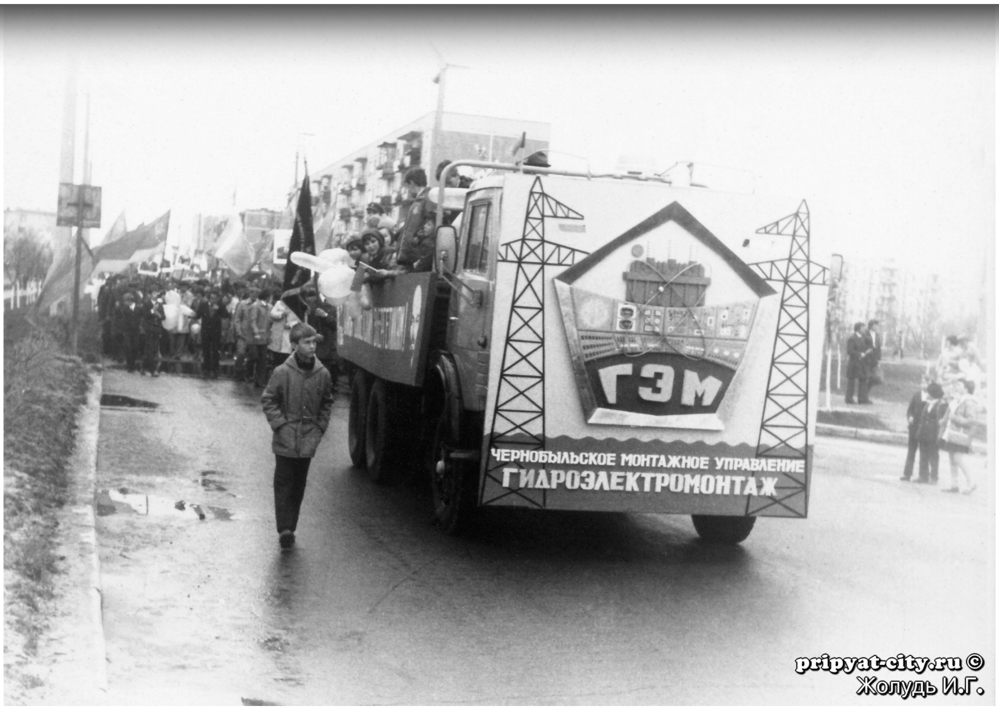

ГЭМ
ЧЕРНОБЫЛЬСКОЕ МОНТАЖНОЕ УПРАВЛЕНИЕ
ГИДРОЭЛЕКТРОМОНТАЖ
pripyat-city.ru ©
Жолудь И.Г.

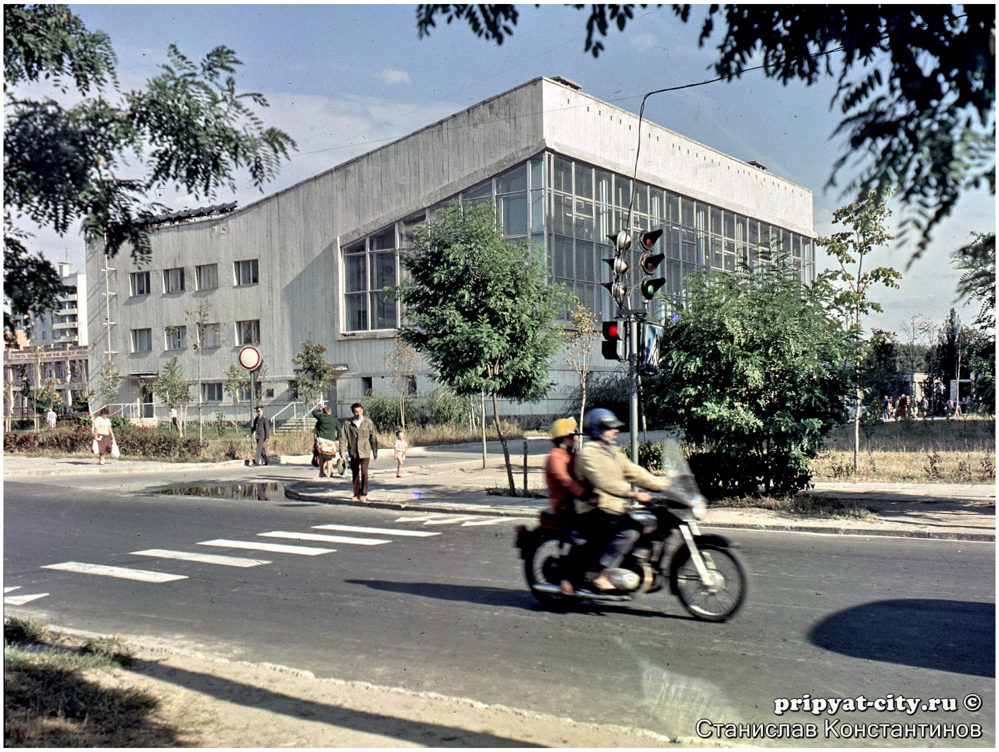
The town held parades praising the nuclear power station and Soviet technology. This truck has a representation of the reactor control room on its front.

МИР
МАЙ
ТРУД

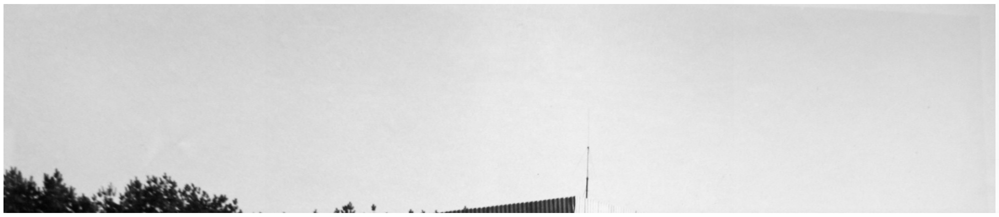
The Chernobyl Story [Updated & Expanded]

By rspc

These old photos provide an interesting portrayal of life in the Soviet Union.


pripyat-city.ru ©
Станислав Константинов

This is the famous swimming pool.



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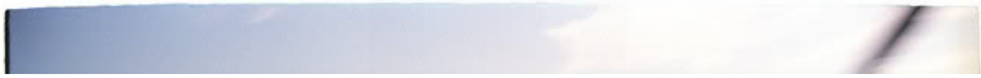
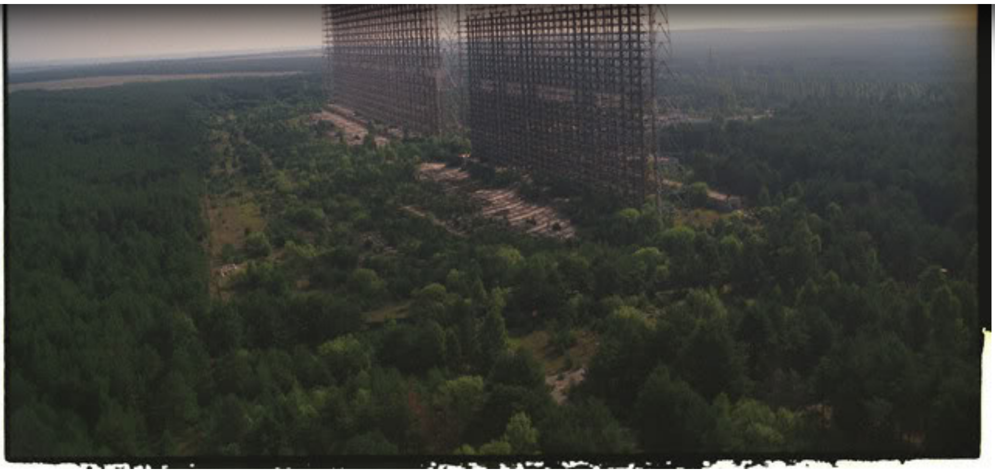
PRIPYAT CITY RU

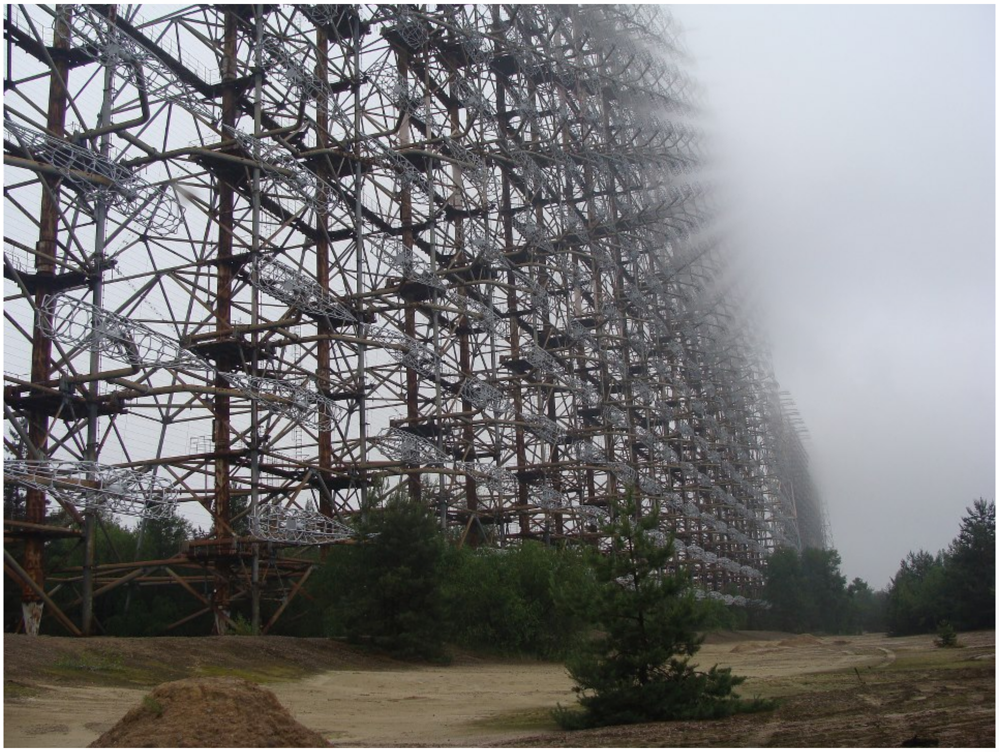
Bus station

pripyat-city.ru ©
Станислав Константинов





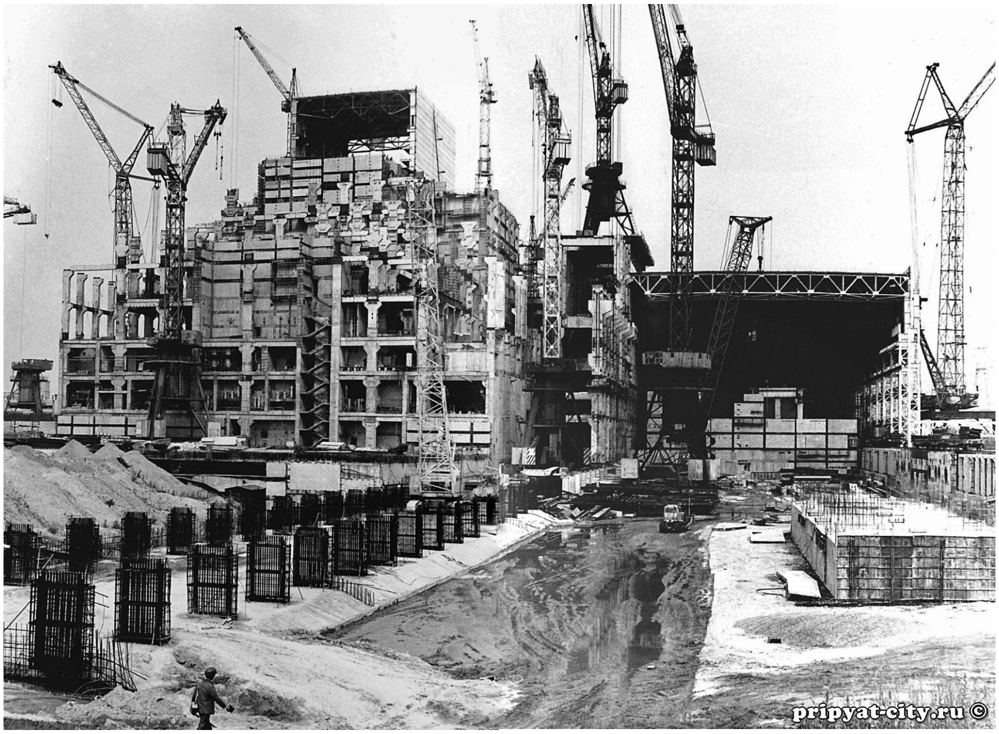
A few kilometers from Pripyat was a new type of over-the-horizon (OTH) radar system, used as part of the Soviet ballistic missile early-warning network. The system operated from July 1976 to December 1989. Two Duga-3 radars were deployed, the other in eastern Siberia.



Starting in 1976 a new and powerful radio signal was detected worldwide, and quickly dubbed the Woodpecker by amateur radio operators. Triangulation quickly revealed the signals came from Ukraine. Confusion due to small differences in the reports being made from various military sources led to the site being alternately located near Kiev, Minsk, Chernobyl, Gomel or Chernihiv. All of these reports were describing the same deployment, with the transmitter only a few kilometers southwest of Chernobyl

pripyat-city.ru ©

Construction at the power station continued throughout the year.



Although complications put the plant two years behind schedule, the first reactor - Unit 1 - was commissioned on the

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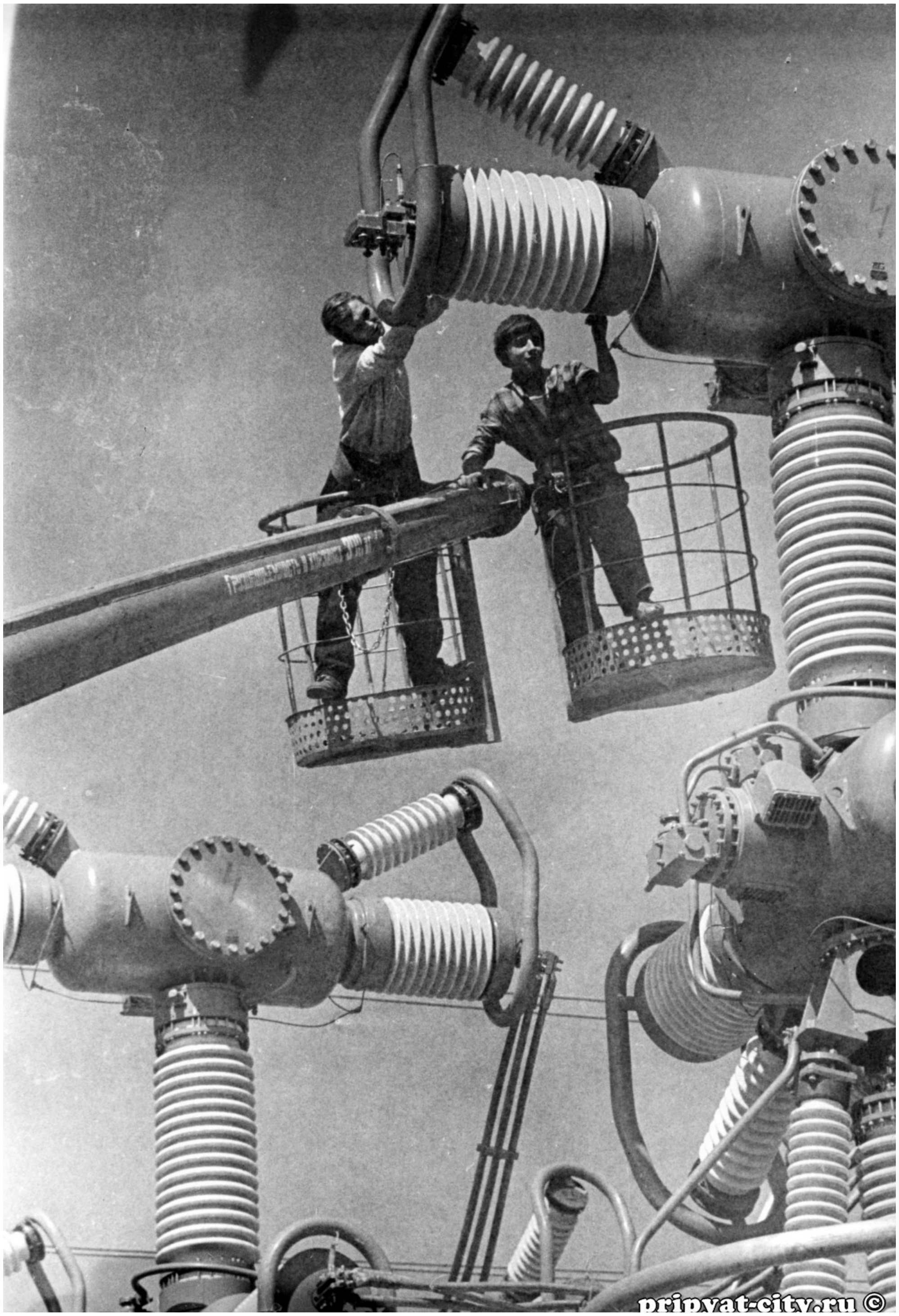
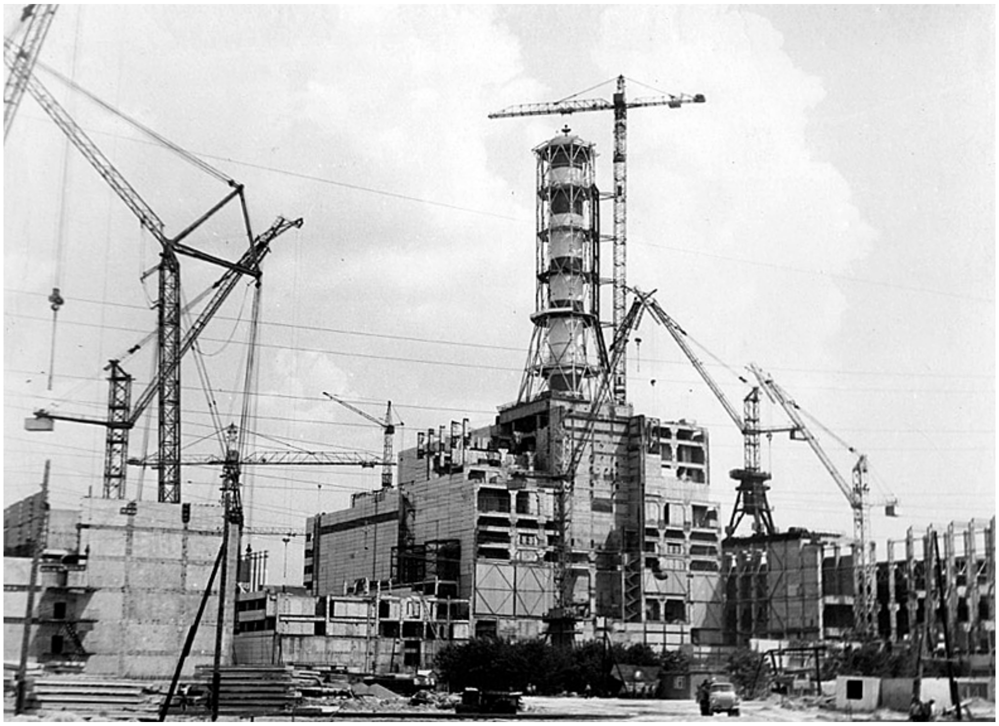
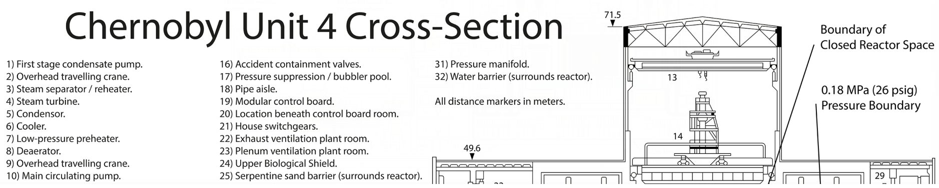


pripyat-city.ru ©

Erecting the power lines.



Here we can see Unit 3 has been completed and the iconic vent chimney is being put into place.


Chernobyl Unit 4 Cross-Section
1) First stage condensate pump.
2) Overhead travelling crane.
3) Steam separator / reheater.
4) Steam turbine.
5) Condensor.
6) Cooler.
7) Low-pressure preheater.
8) Deaerator.
9) Overhead travelling crane.
10) Main circulating pump.
16) Accident containment valves.
17) Pressure suppression / bubbler pool.
18) Pipe aisle.
19) Modular control board.
20) Location beneath control board room.
21) House switchgears.
22) Exhaust ventilation plant room.
23) Plenum ventilation plant room.
24) Upper Biological Shield.
25) Serpentine sand barrier (surrounds reactor).
31) Pressure manifold.
32) Water barrier (surrounds reactor).
All distance markers in meters.
71.5
49.6
13
14
29
Boundary of Closed Reactor Space
0.18 MPa (26 psig) Pressure Boundary

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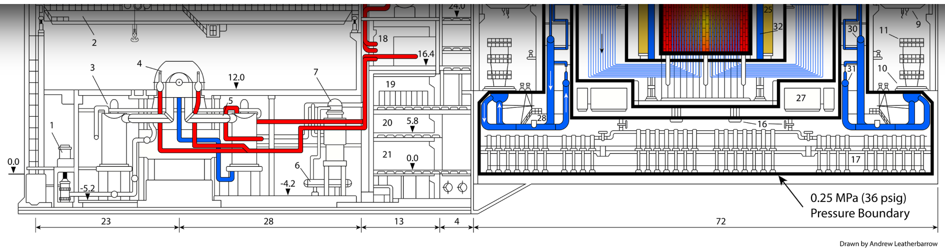
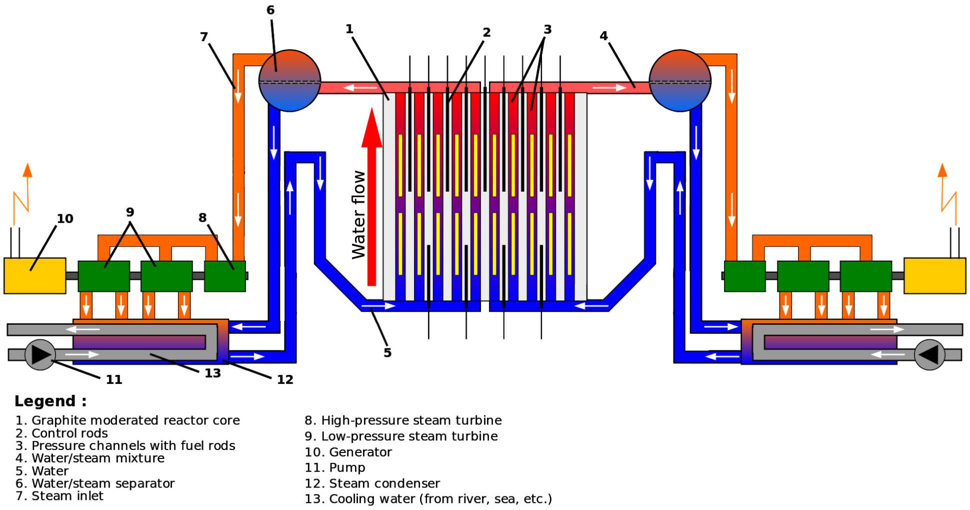
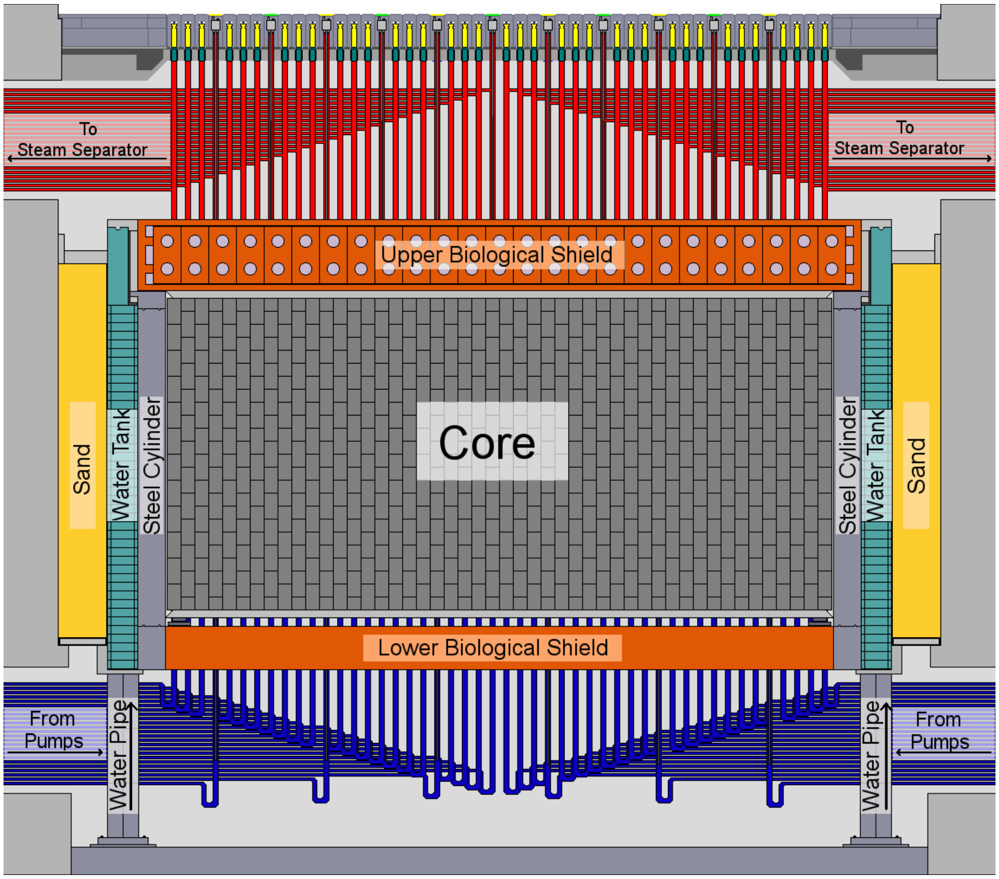

24.0
18
16.4
12.0
19
20
5.8
21
0.0
-4.2
-5.2
0.0
30
31
32
27
28
16
17
11
10
9
23
28
13
4
72
0.25 MPa (36 psig)
Pressure Boundary
Drawn by Andrew Leatherbarrow

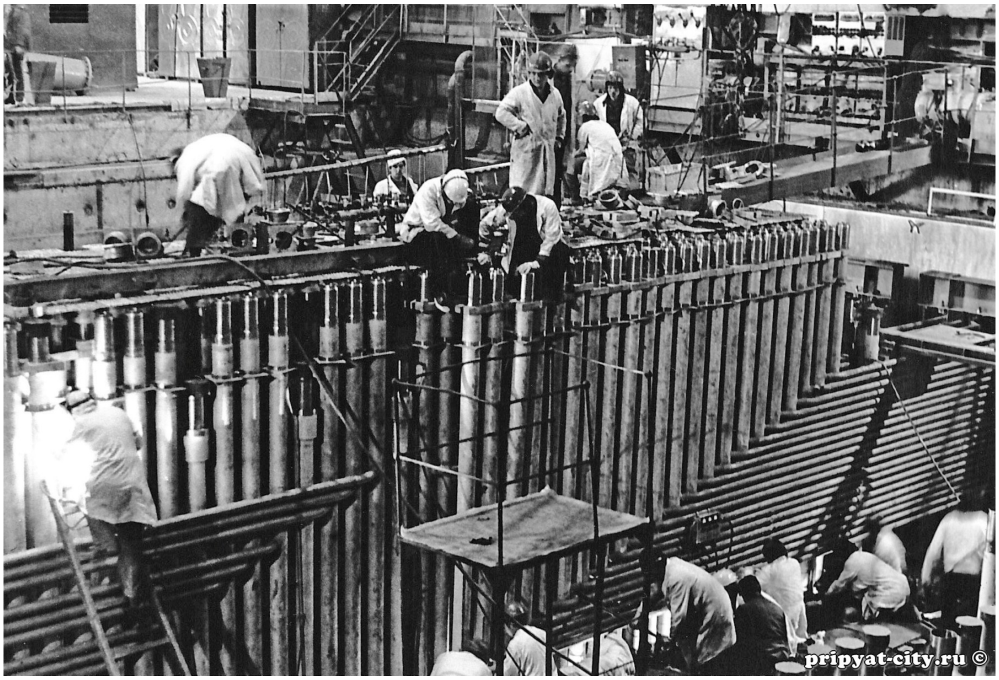
I drew this diagram based on two different existing ones. All cross-sections. It shows how the building is laid out, including where the pumps, steam separators and turbines are. The only examples I've seen online are very low resolution, so this one is a bit more useful at 3000px. It was 12,000px but it kept crashing the album for people, so I've made it smaller. If anyone wants a bigger one, just email me at leatherbarrowa@gmail . com


Water flow
1
2
3
4
5
6
7
8
9
10
11
12
13
Legend :
1. Graphite moderated reactor core
2. Control rods
3. Pressure channels with fuel rods
4. Water/steam mixture
5. Water
6. Water/steam separator
7. Steam inlet
8. High-pressure steam turbine
9. Low-pressure steam turbine
10. Generator
11. Pump
12. Steam condenser
13. Cooling water (from river, sea, etc.)

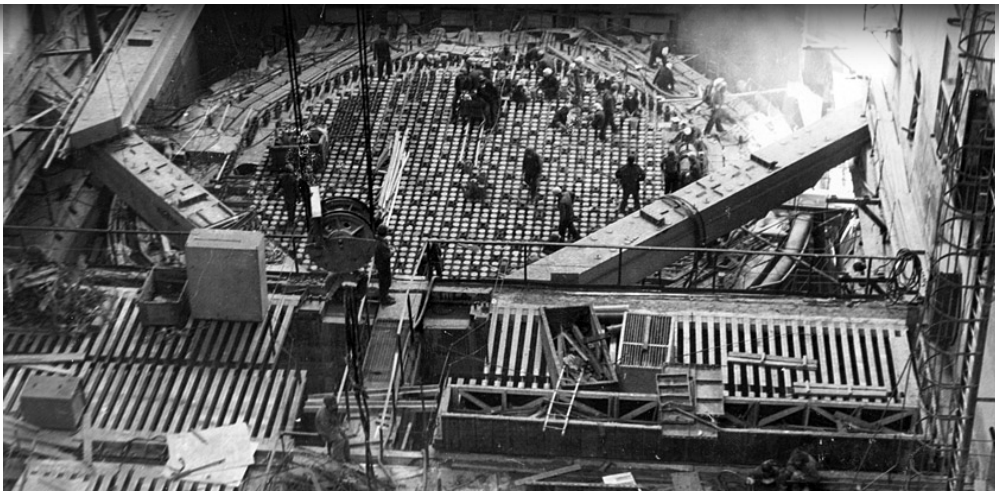
All four reactors were of the relatively new RBMK-1000 type, which stood for Reaktor Bolshoy Moshchnosti Kanalnyy ("High Power Channel-type Reactor" in English). Measuring a massive 7 metres tall by 11.8 metres wide, with each capable of outputting construction. Two of these were being built at Chernobyl on the night of the accident in 1986, with Unit 5 expected to be completed later that year.


To Steam Separator
To Steam Separator
Upper Biological Shield
Sand
Water Tank
Steel Cylinder
Core
Steel Cylinder
Water Tank
Sand
Lower Biological Shield
From Pumps
Water Pipe
Water Pipe
From Pumps

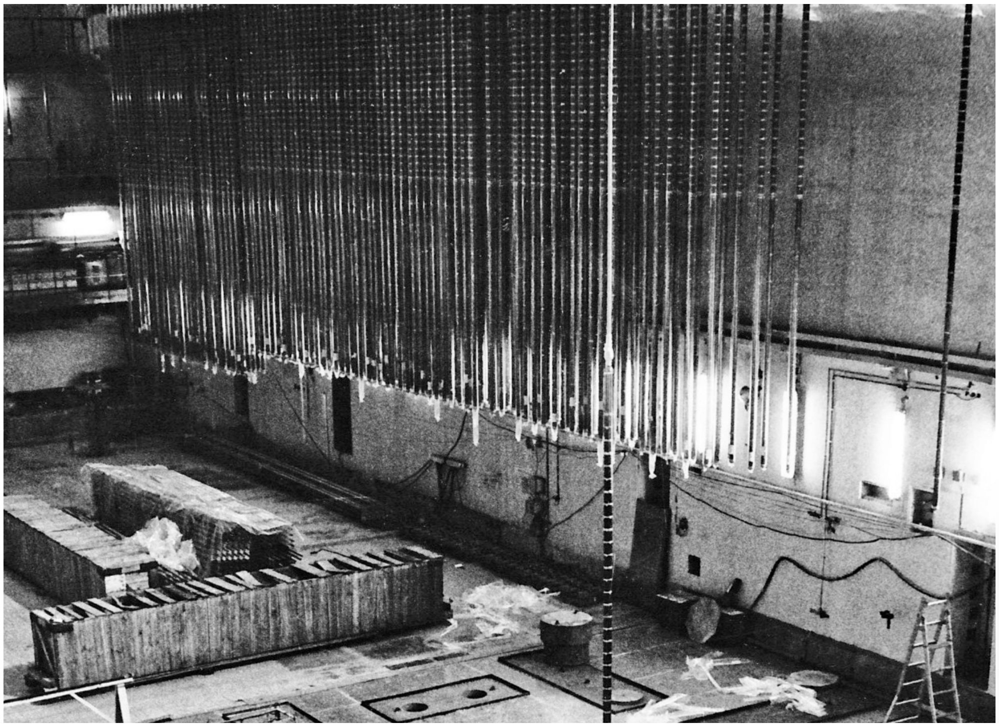
A fission reaction is enabled by what is known as a neutron moderator, which, in an RBMK reactor, is comprised of vertical graphite blocks surrounding the fuel channels. Each RBMK contains 1850 tons of graphite. This graphite slows - moderates - the speed of neutrons moving in the fuel, because slowed neutrons are far more likely collide with uranium235 nuclei and split. When playing golf, for example, if your ball is a few atomic split occurs, the more the chain reaction sustains itself and the more energy is produced. In other words, the graphite moderator creates the right environment for a chain reaction. Think of it as oxygen in a conventional fire: even with all the fuel in the world, there will be no flame without oxygen.

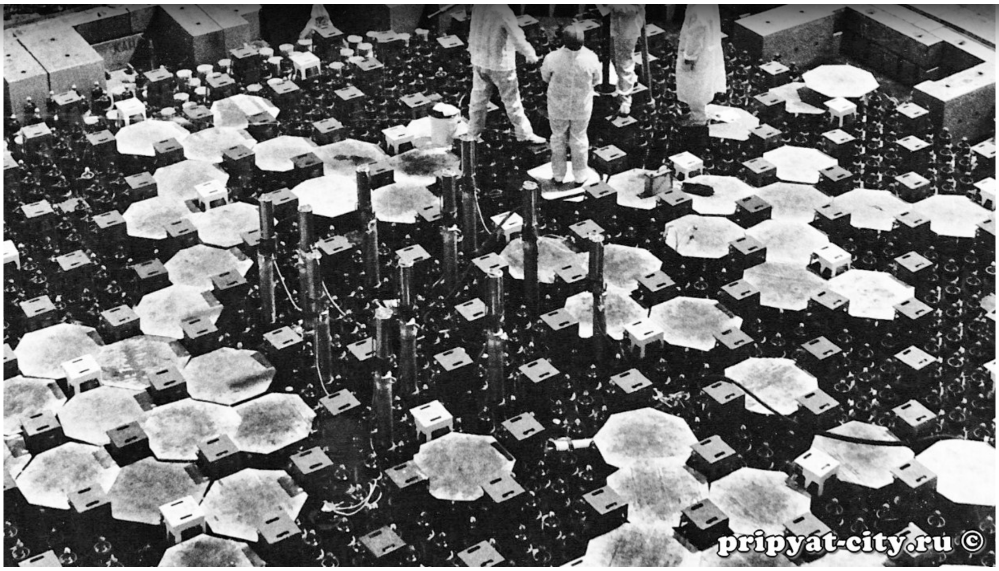


The pumps push pressurised water through these pipes and up into the bottom of the core at a temperature of 270°C. This is just below the boiling point at the pressure inside the system (approximately 1000psi, or 65 atmospheres). Once inside the reactor core, the water boils and comes out of the top at 284°C.



Reactor construction. You can start to see how big the RBMK is here.



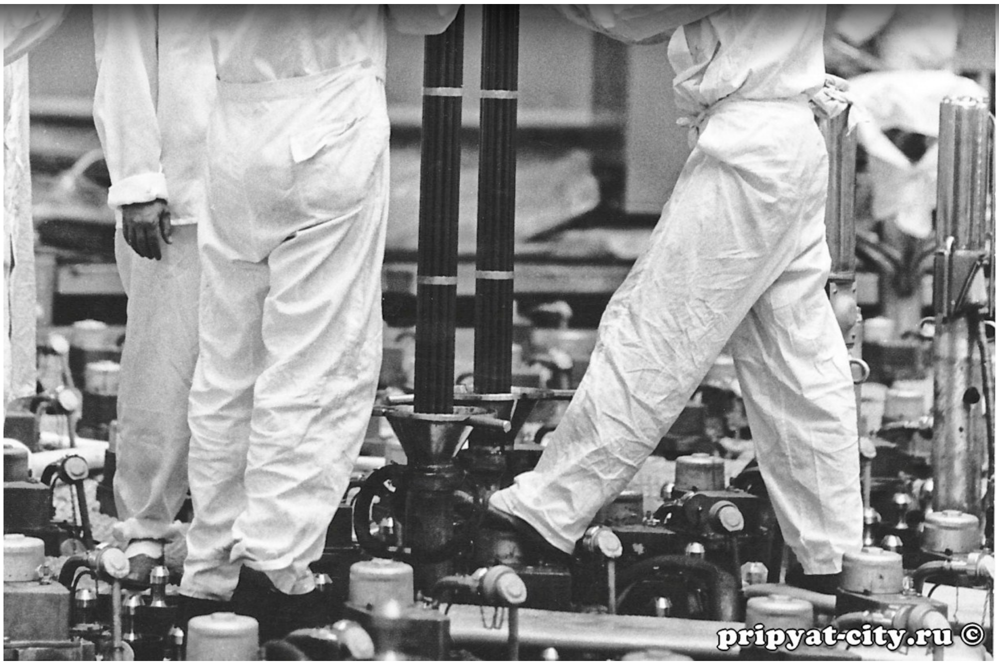

pripyat-city.ru ©

Lowering fuel fuel into the completed reactor.

ДАЁШЬ ФИ –ПУСК

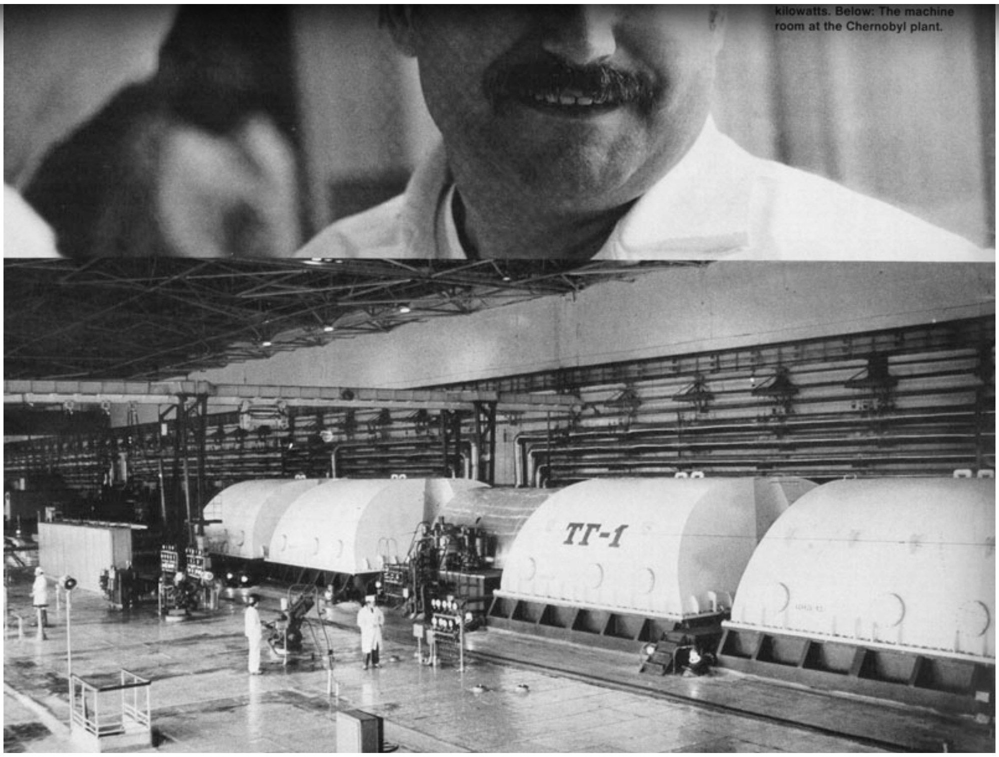
The Chernobyl Story [Updated & Expanded]

By rspc



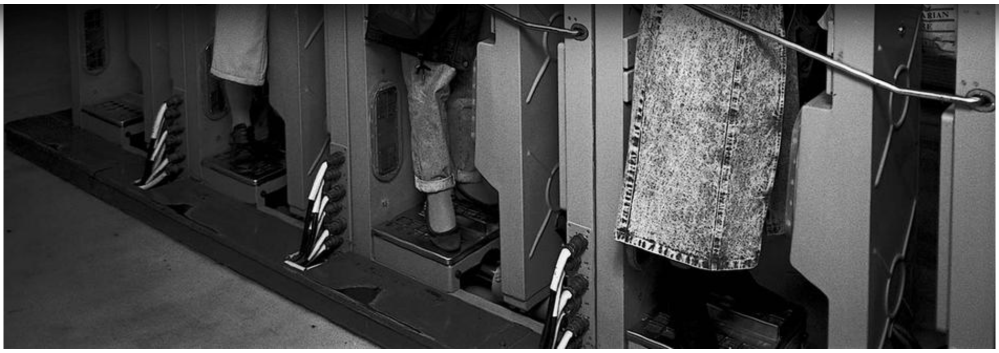
Brand new fuel rods are fairly harmless.

Pyotr Bondarenko, a shift superintendent in the department of labor protection and safety review at the Chernobyl Nuclear



kilowatts. Below: The machine room at the Chernobyl plant.

This was printed a few years before the accident.



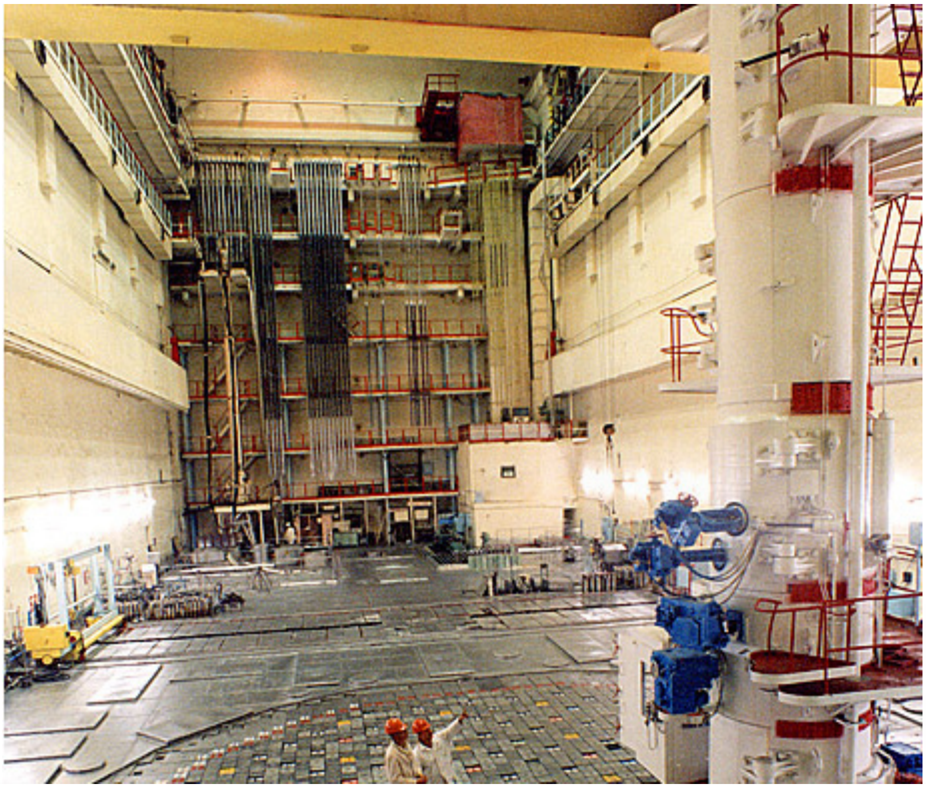
Once the power station was up and running, all staff entering and exiting the complex had to go through these radiation detectors. They're still used at the site today.

The Chernobyl Story [Updated & Expanded]

By rspc

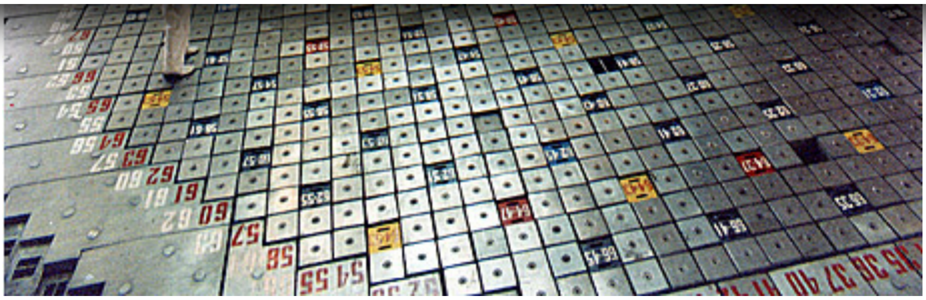
Ilya Varlamov I zyalt.livejournal.com

Here you can see the top of one of the gigantic pumps used to push water into the core. The water is pumped through the reactor and then up through a condensator, which separates steam from water. The remaining water returns to the pump and is fed back into the reactor.

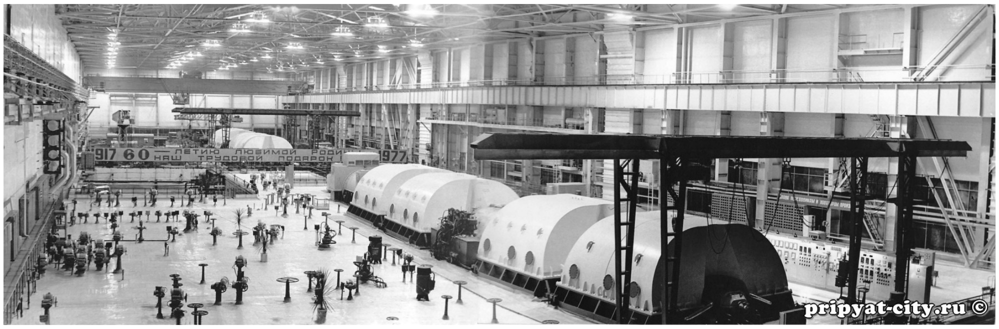


The Chernobyl Story [Updated & Expanded]

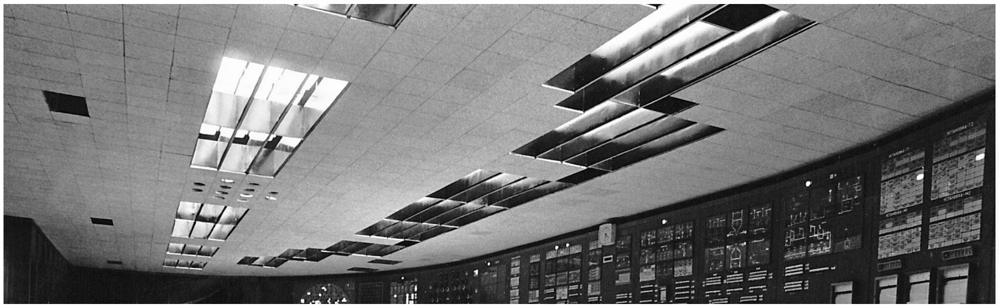
By rspc

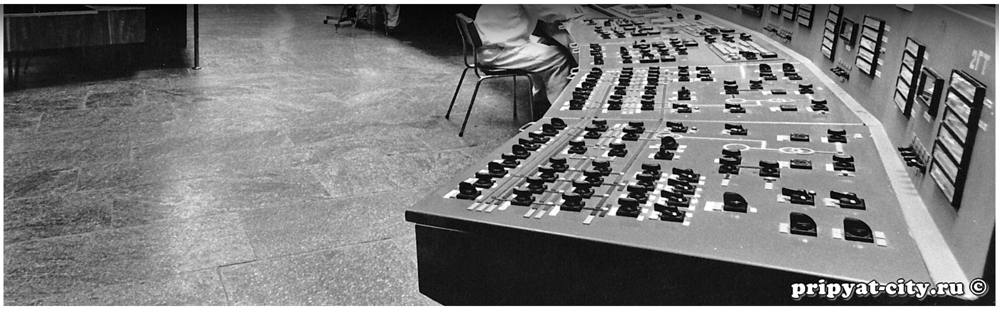


On the right is a refueling machine. Once it's positioned over the correct fuel channel, it withdraws the fuel rod and replaces it with a fresh one while the reactor is still operating. This is called on-load refuelling.

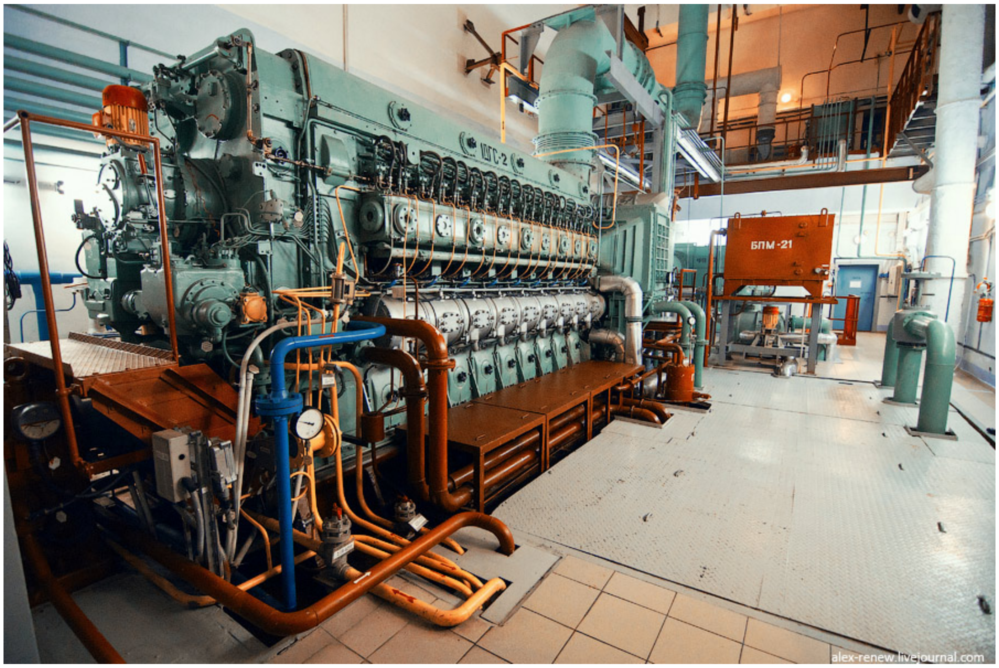


One section of the completed turbine hall. Steam from the condensator enters these steam turbines, which turn and generate electricity. Having passed through the turbogenerator, the steam is condensed back into water and fed back to the pumps, where it begins its cycle again.





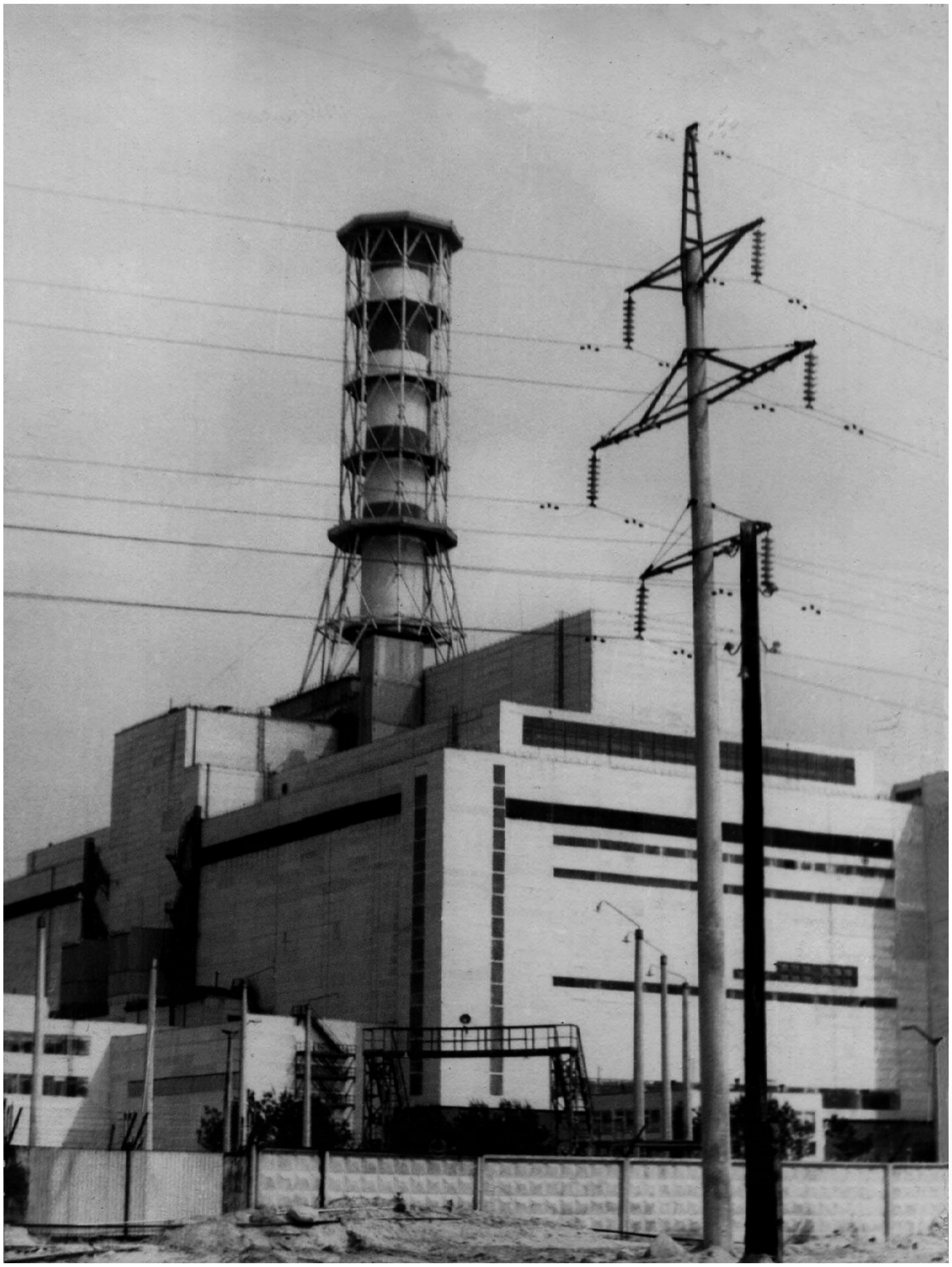
Here is one of the control rooms. There's one control room for each reactor - four in all at Chernobyl.



The principal concern of any nuclear reactor - particularly an RBMK, because of its graphite moderator - is that cooling water continuously flows into the core. Without it there could be an explosion or meltdown. Even if the reactor is shut down, the fuel but in the event of a blackout the electrical supply can be switched to the national grid. If that fails, diesel generators on site will automatically start up to power the water pumps, but these take about 50 seconds to gather enough energy to operate the massive pumps. There are six emergency tanks containing a combined 250 tons of pressurised water which can be injected into the core within 3.5 seconds, but an RBMK reactor needs around 37,000 tons of water per hour - 10 tons per second - so 250 tons does not cover the 50 second gap.

PRIPYAT·CITY·RU
ВСЕ О ГОРОДЕ ПРИПЯТЬ

In the early morning of April 26th 1986, a team of men at the power station were testing a safety feature of the RBMK design that allowed the system to power the pumps by itself for that vital minute before the diesel engines took over. If a power failure occurred, the fission reaction would still be producing heat, while the remaining water in the pipes would continue its momentum for a short time and therefore steam would still be few vital moments, giving the diesel generators sufficient time to get up to speed and take over, and it’s the hardware behind this that was being tested.



The Chernobyl Story [Updated & Expanded]

By rspc

This is the only good image I've ever found of Chernobyl from the angle it's most commonly now seen from.

This is 26-year-old Senior Reactor-Control Engineer Leonid Toptunov, one of the control room operators. He made a mistake when switching from manual to automatic control of the control rods, causing them to descend much farther into the core than intended. This resulted in an almost total shutdown of the reactor. Safety procedures required that the operators fully shutdown the reactor, as the RBMK became unstable at very low power. Unfortunately for the whole world, the Deputy Chief Engineer in charge that night - Anatoly Dyatlov - insisted that they continue. Over the next hour, the men struggled to bring the reactor up to power, disabling various safety systems in the process, and then began the test.

The Chernobyl Story [Updated & Expanded]

By rspc

At 01:23:04, turbine 8 was disconnected and began to coast down. Exactly what happened over the next moments is not entirely clear. The power remained level, but something appears to have been going on in the labyrinth of pipes and pumps. An internal USSR report later wrote "In the Commission's opinion, the substantial fuel damage... did in fact happen. However, although the authors... confirm the strong dependence of the results on slight variations in the initial data, they did not find initial values which would have given rise to the accident process. They conclude that there must have been some other factors, in addition to the unfavourable reactivity excursion caused by the [control] rods, in order to account for the accident. The factors suggested include Main Circulating Pump (MCP) cavitation, entry of non-equilibrium steam at the core inlet, switching off of the MCPs being run down prior to the [emergency shutdown] signal, coolant boiling at the reactor inlet, partial leaks in the lower water channels, and opening of the steam safety valves briefly." Other reports and simulations definitively ruled out any strange phenomena in the core and could not find a reason for the emergency shutdown button to be pressed. Some said there were shouts as Toptunov and Akimov saw dangerous readings on their control boards.

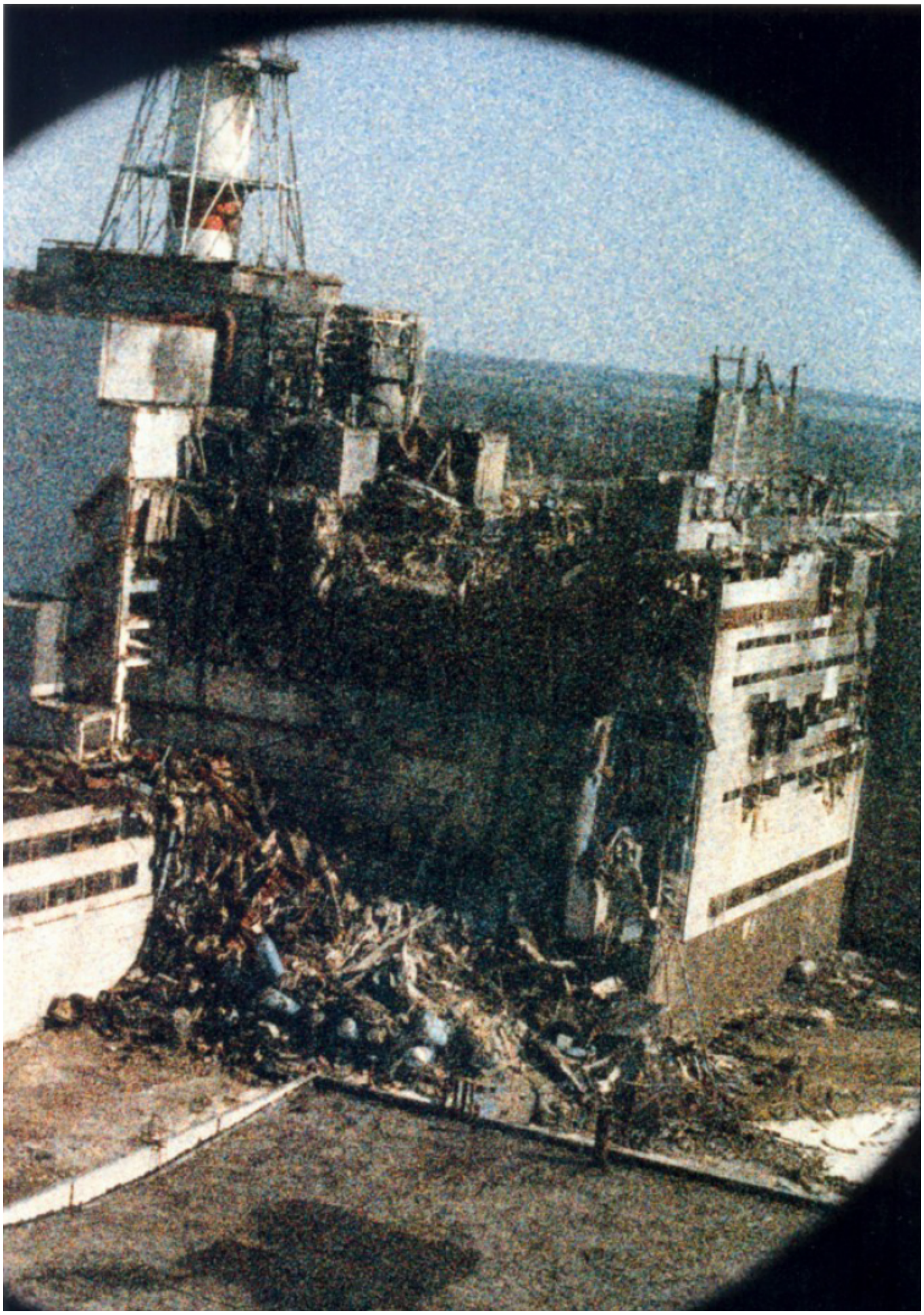
Regardless, at precisely 01:23:40, Akimov pressed the emergency shutdown button. Within 4 seconds, the main circulating pumps began to cavitate and fill with steam, reducing the flow of valuable cooling water and allowing steam voids (pockets of steam where there should be water) to form in the core the reactor’s energy output had soared to several times its intended capacity. A positive void coefficient was occurring: the absence of cooling water causing an exponential power increase. In simple terms, more steam = less water = more power = more heat = more steam. Runaway heat and pressure deep inside the core ruptured fuel channels, then water pipes, causing the pumps’ automatic safety valves to close. This stopped the flow of coolant, increasing the rate at which steam was forming from the core’s diminishing water supply. The reactor’s own safety valves attempted to vent the steam, but the pressure was too great and they, too, ruptured. At precisely 01:23:58, a mere 18 seconds after Akimov pressed the SCRAM button, a steam explosion blew the 450-ton upper biological shield clear off the reactor before it crashed back still from a Ukrainian 4-episode TV series (and also edited into a movie) from 2013 called Inseparable. You can read more about it here: http://film.ua/en/distribution/projects/241 and here: http://film.ua/en/news/822 The entire film can be watched (with English subtitles) on YouTube here: https://www.youtube.com/watch?v=fT7XyBs9yNI

pripyat-city.ru ©

“There was a heavy thud,” remembered engineer Sasha Yuvchenko in a 2004 interview with the Guardian newspaper. He was only 24 years-old in 1986. “A couple of seconds later, I felt a wave come through the room. The thick concrete walls were bent like rubber. I thought war had broken out. We started to look for Khodemchuk (seen here on the left), but he had been by the pumps and had been vaporised. Steam wrapped around everything; it was dark and there was a horrible hissing

The Chernobyl Story [Updated & Expanded]

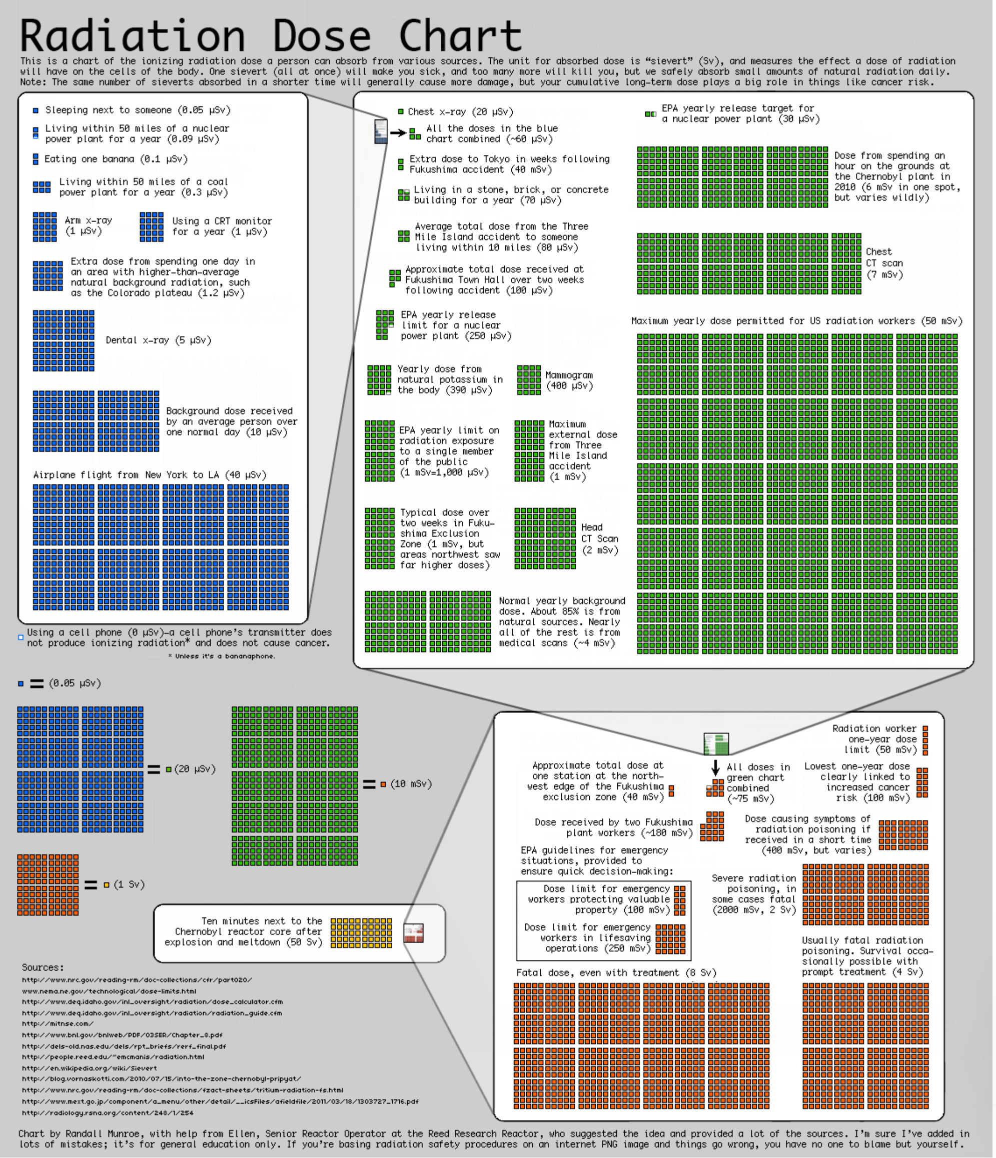
By rspc



The Chernobyl Story [Updated & Expanded]

By rspc

This is believed to be the first photograph ever taken of the accident, and the only photo that survives from that morning. Igor Kostin was a photographer from Kiev who became world famous for his images of the the clean-up operation. Kostin claims the image is very noisy because radiation was destroying the film in his camera. Of all the shots he took on that flight, this is the only one that wasn't ruined.



This is a chart of the ionizing radiation dose a person can absorb from various sources. The unit for absorbed dose is "sievert" (Sv), and measures the effect a dose of radiation will have on the cells of the body. One sievert (all at once) will make you sick, and too many more will kill you, but we safely absorb small amounts of natural radiation daily. Note: The same number of sieverts absorbed in a shorter time will generally cause more damage, but your cumulative long-term dose plays a big role in things like cancer risk.

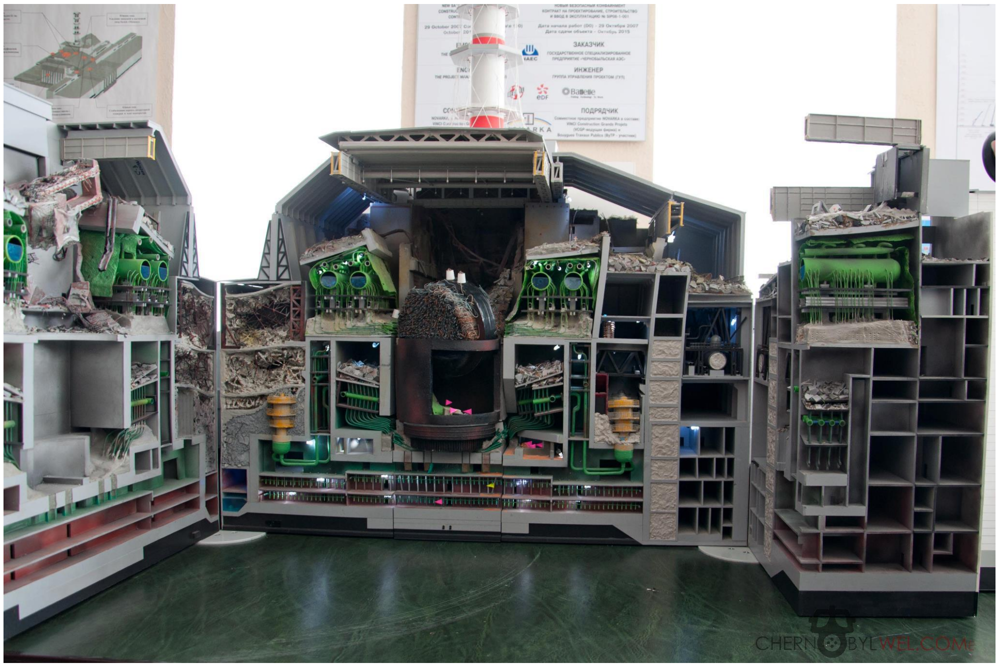
Sources:
http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/
www.nema.ne.gov/technological/dose-limits.html
http://www.deq.idaho.gov/inl_oversight/radiation/dose_calculator.cfm
http://www.deq.idaho.gov/inl_oversight/radiation/radiation_guide.cfm
http://mitnse.com/
http://www.bnl.gov/bnlweb/PDF/03SER/Chapter_8.pdf
http://dels-old.nas.edu/dels/rpt_briefs/rerf_final.pdf
http://people.reed.edu/~emcmanis/radiation.html
http://en.wikipedia.org/wiki/Sievert
http://blog.vornaskotti.com/2010/07/15/into-the-zone-chernobyl-pripyat/
http://www.nrc.gov/reading-rm/doc-collections/fzact-sheets/tritium-radiation-fs.html
http://www.mext.go.jp/component/a_menu/other/detail/__icsFiles/afieldfile/2011/03/18/1303727_1716.pdf
http://radiology.rsna.org/content/248/1/254

Chart by Randall Munroe, with help from Ellen, Senior Reactor Operator at the Reed Research Reactor, who suggested the idea and provided a lot of the sources. I'm sure I've added in lots of mistakes; it's for general education only. If you're basing radiation safety procedures on an internet PNG image and things go wrong, you have no one to blame but yourself.

The Chernobyl Story [Updated & Expanded]

By rspc

This is a wonderful diagram illustrating just how intense the radioactivity was after the accident. Credit to Randall Munroe who made the image.



This model from the plant's visitor centre shows how the internal structure of the building now looked.

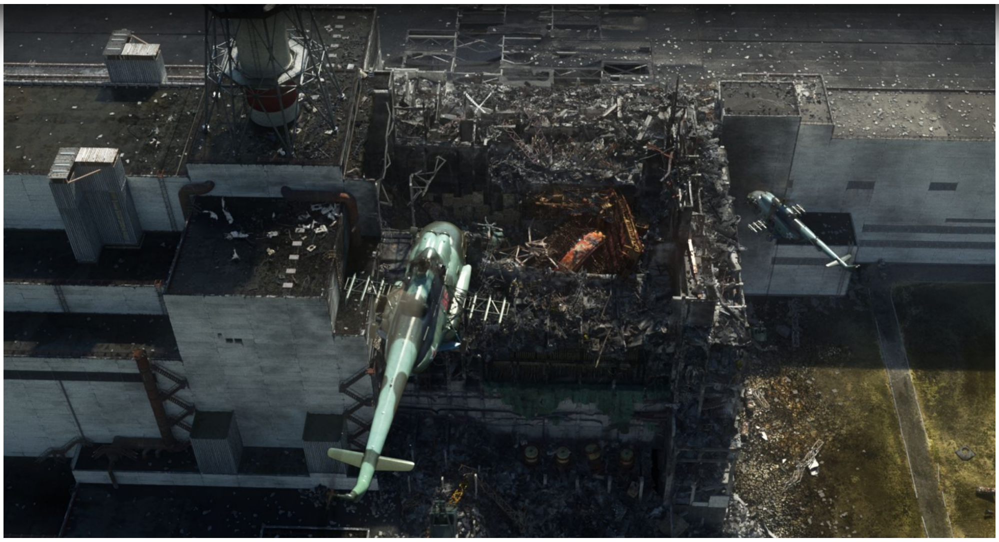
The Chernobyl Story [Updated & Expanded]

By rspc

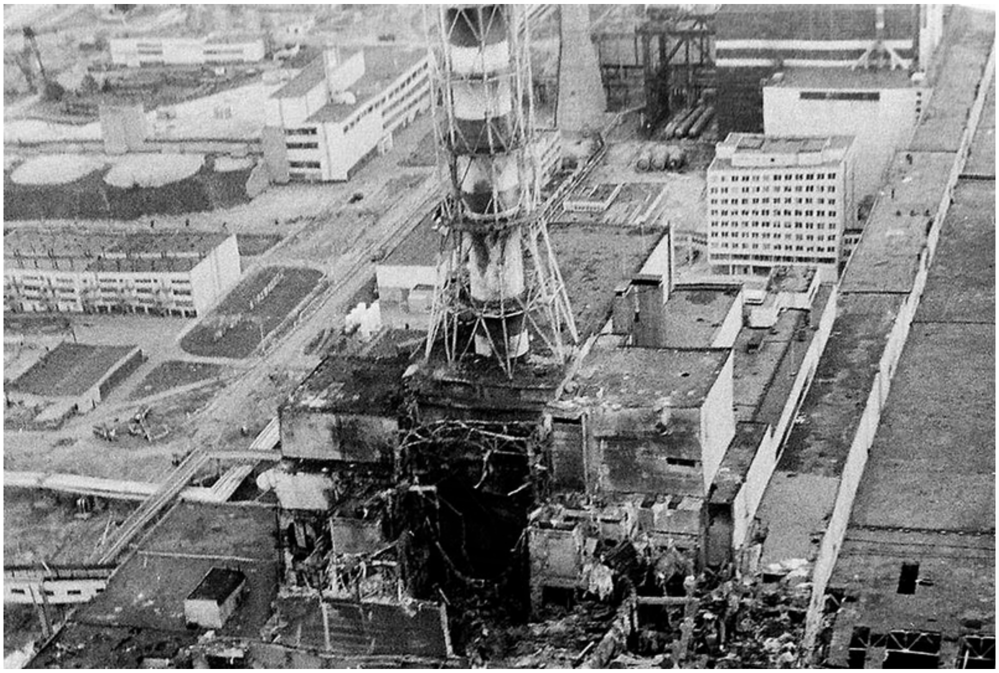
The plant's own firemen immediately rushed into action. The explosion had started fires all over the site, which threatened to destroy the nearby Unit 3. These brave souls climbed onto the roof overlooking the destroyed reactor and fought fires for hours as the radiation destroyed their bodies.

The Chernobyl Story [Updated & Expanded]

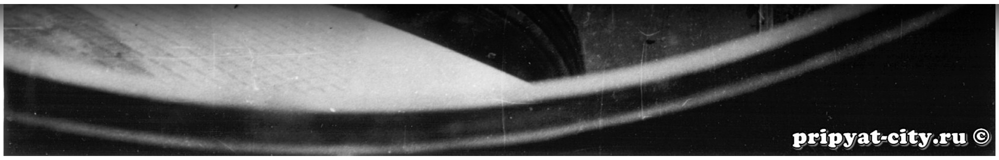
By rspc



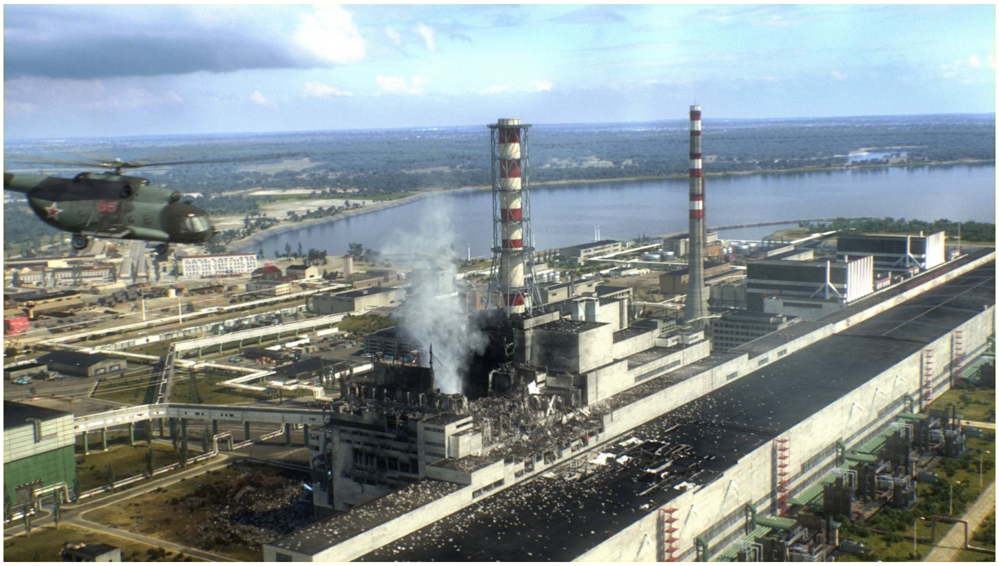
This isn't a photograph, but a very accurate recreation of the building that morning. You can clearly see the upper biological shield has been completely dislodged and is resting at a sharp angle.



When questioned on the level of radiation in and around the plant, dosimetrists reported that the only functional radiometer they could find indicated 1,000μR/s - 3.6 roentgens-per-hour. Compared to normal levels this was high, but not immediately life threatening. Bryukhanov and Dyatlov assumed this was an accurate measurement, despite knowing it was the maximum measurement the device could display. In reality, radiation levels were as high as 8,000,000μR/s - a staggering 30,000 roentgens-per-hour - in some parts of the plant. Bryukhanov declared the devices were broken and repeatedly told his superiors in Moscow that the accident was only minor and the reactor was still intact.

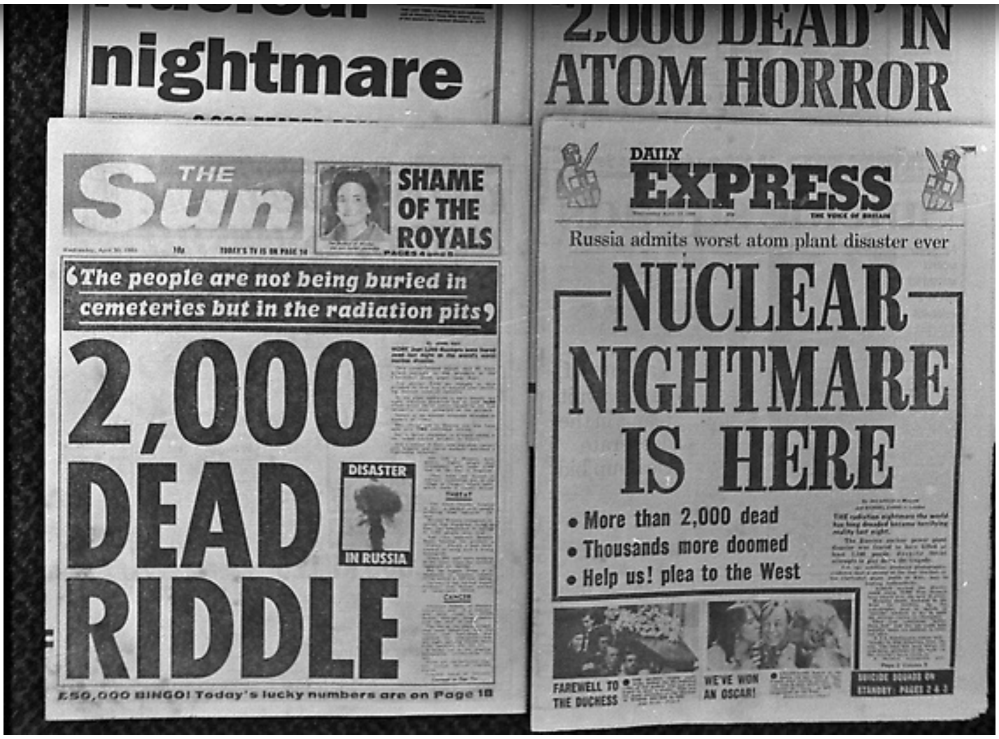


The smoke seen here is a mixture of incredibly radioactive particles venting into the atmosphere. This cloud would spread radioactivity across Europe.



The outside world remained ignorant of the accident at Chernobyl until the morning of Monday the 28th of April, when a sensor detected elevated radiation levels on engineer Cliff Robinson as he arrived for work at Sweden's Forsmark Nuclear Power Plant, over 1,000 kilometers away.

The Windsor love letters—Pages 23-25



nightmare

2,000 'DEAD' IN ATOM HORROR

THE Sun

SHAME OF THE ROYALS

'The people are not being buried in cemeteries but in the radiation pits'

2,000 DEAD RIDDLE

DISASTER IN RUSSIA

£50,000 BINGO! Today's lucky numbers are on Page 18

DAILY EXPRESS

Russia admits worst atom plant disaster ever

NUCLEAR NIGHTMARE IS HERE

- More than 2,000 dead
- Thousands more doomed
- Help us! plea to the West

FAREWELL TO THE DUCHESS

WE'VE WON AN OSCAR!

SUICIDE SQUADS ON STANDBY: PAGES 2 & 3

Following the news, global media had a fit and made wild assumptions about the accident. In fact, only 2 men had died when these were published.

The Chernobyl Story [Updated & Expanded]

By rspc

pripyat-city.ru ©

The most prominent scientific member of the commission was 49-year-old Academician Valerii Legasov. Legasov held a Doctorate in Chemistry and was something of a prodigy, having enjoyed an unprecedented rise within Soviet scientific circles to become the First Deputy-Director of the prestigious I. V. Kurchatov Institute of Atomic Energy. Even though he was not a specialist in nuclear reactors, he was a highly intelligent, experienced and influential figure, both within the Communist Party and the global scientific community.

The Chernobyl Story [Updated & Expanded]

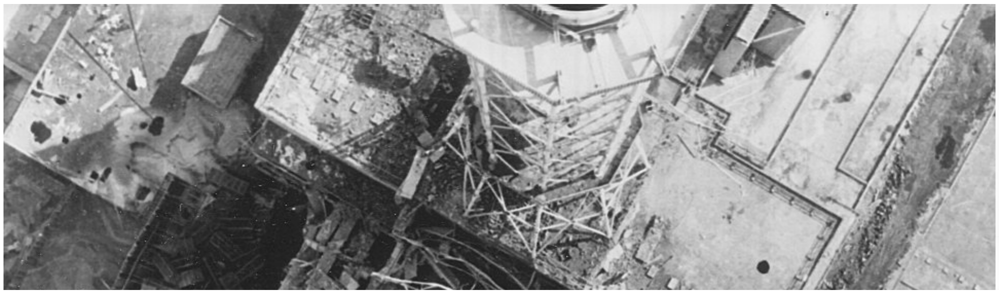
By rspc

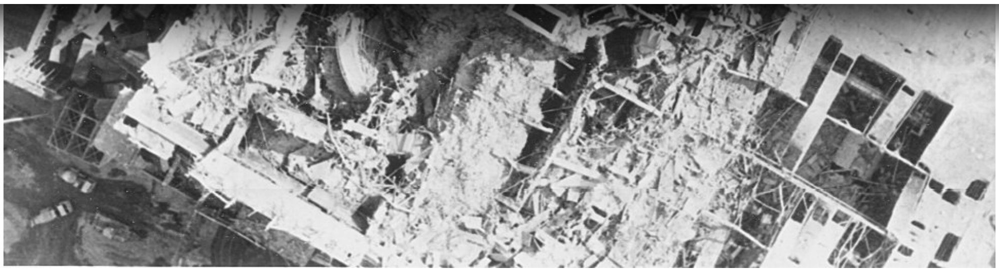
pripyat-city.ru ©

A special government commission consisting of Party officials and scientists were on their way to assess the situation, and would arrive over the following 24 hours. The commission's leader was this man: Boris Scherbina, Deputy Chairman of the Council of Ministers of the USSR and a former Minister for Construction in the oil & gas industry. While not a low-level politician, Scherbina was not a member of the Politburo - the Soviet political elite - because nobody in the government realised how serious the accident was at this stage.

YAPLAKAL.COM

Their most pressing concern was that the reactor core could be still undergoing nuclear fission. It could get hot enough to melt its way through the entire structure of the building to the flooded basement and pressure suppression pool below. It might even burn down to the earth. Either result could have triggered another, far more serious explosion - they had to extinguish the fire at all costs. Legasov suggested using helicopters to drop sand mixed with boronic acid to neutralise the reaction. After the first day, an Air Force general proudly told Shcherbina that 150 tons had been dropped. He responded, “150 tons of sand for a reactor like that is like a BB shot to an elephant.” On April 28th, helicopters dumped 300 tons of sand onto the reactor. On the 29th: 750 tons; on the 30th: 1,500 tons; on May 1st, May Day, a popular annual holiday in the Soviet Union: 1,900. In total, around 5,000 tons of materials fell onto the reactor.





Here you can see how much material was dropped by the fleet of helicopters. Unfortunately, almost all of it completely missed its target, and what little did reach the reactor only served to cut off the cooling heat-exchange effect between the core and the atmosphere. The core temperature increased. During the operation, one of the helicopters crashed. There's a video of the crash here: http://www.youtube.com/watch?v=zuNtgYtF4FI

What happened next runs contrary to every English-language account ever written prior to 2016, which all said these men died. After a daring mission to drain Chernobyl's flooded basement by firemen, three of Chernobyl's staff donned with the walking stick), in April 2018 receiving a medal for his bravery from Ukraine's Prime Minster. The group found the valves they were searching for amongst the tangle of pipes and successfully drained the pressure suppression pool. All three survived their ordeal and continued to work at the plant and lived for decades. Above is a photograph of Ananenko at Chernobyl in April 2018 receiving a medal for bravery from Ukraine's Prime Minister.

With the immediate worry of the flooded basement taken care of, the next problem was the earth beneath Chernobyl. Miners were brought in to dig a 150 meter tunnel underneath Unit 4, where a special refrigeration device would be installed below the building, in an attempt to cool the core. Scientists worried that pneumatic drills would stress the building’s fragile foundations, so the miners were ordered to dig their tunnel by hand. They worked 24 hours a day and achieved their goal in a month, but many of them later died from exposure, and their

The Chernobyl Story [Updated & Expanded]

By rspc

pripyat-city.ru ©

The residents of Pripyat knew there had been an accident, but had no idea how severe it was, and went about their day as usual on Saturday the 26th. Word spread throughout the day that something serious had gone wrong. In order to prevent panic, no information was provided about what had happened at the plant. Those who tried to leave town soon discovered that police had set up roadblocks to stop anyone entering or leaving the area.

The Chernobyl Story [Updated & Expanded]

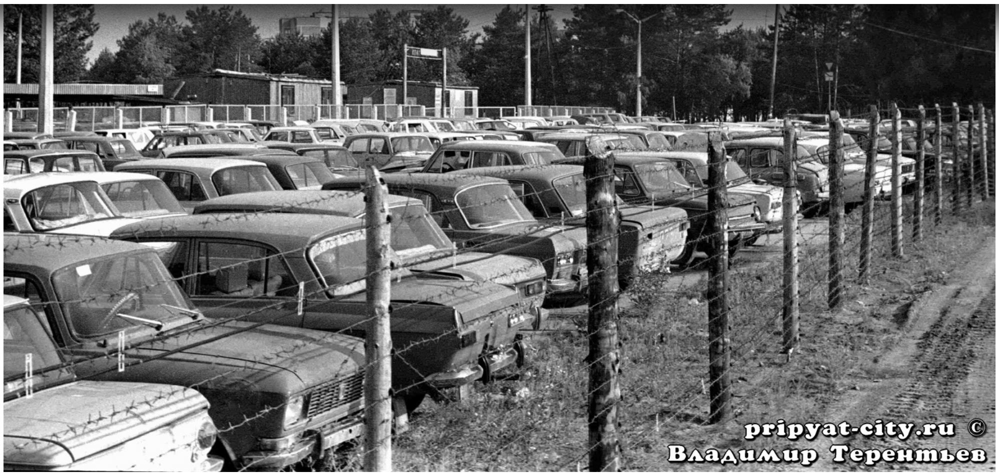
By rspc

pripyat-city.ru ©

On the morning of the 27th, as the radiation levels in Pripyat peaked, Legasov remarked that, “mothers could be seen pushing prams and children were playing in the street – just like any other Sunday.” The order to evacuate was finally given at 11am on April 27th, 34 hours after the accident. These two photos are from shortly after the evacuation.

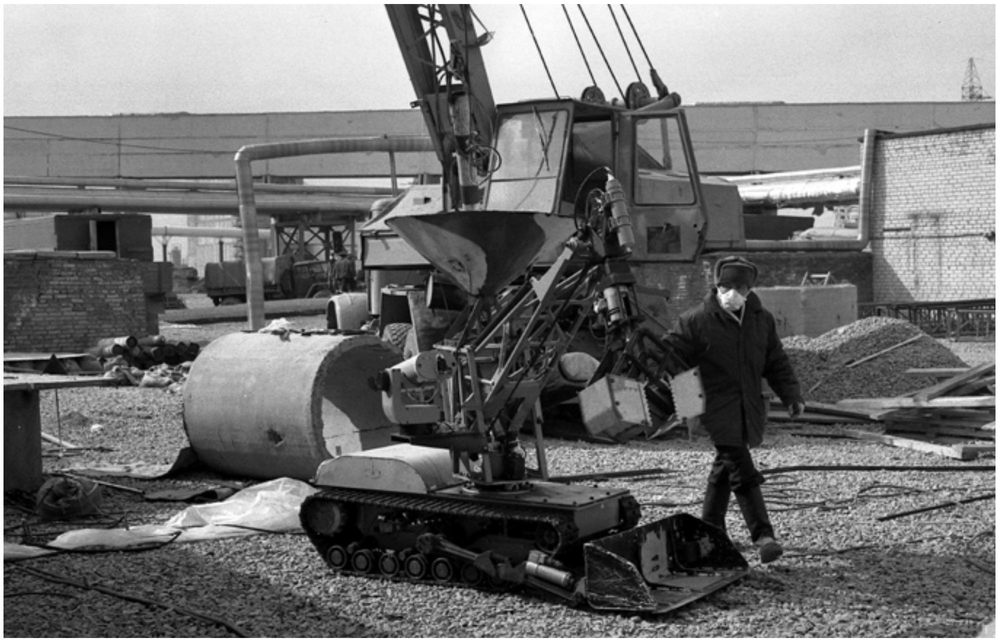
The Chernobyl Story [Updated & Expanded]

By rspc


pripyat-city.ru ©
Владимир Терентьев

As seen in the previous photo, all the radioactive cars were gathered together at the edge of the city.

СЛАВЬСЯ,
ОТЕЧЕСТ О
НАШЕ
СВОБОДН Е
PRIPYAT·CITY.RU
ВСЁ О ГОРОДЕ П ИПЯТЬ

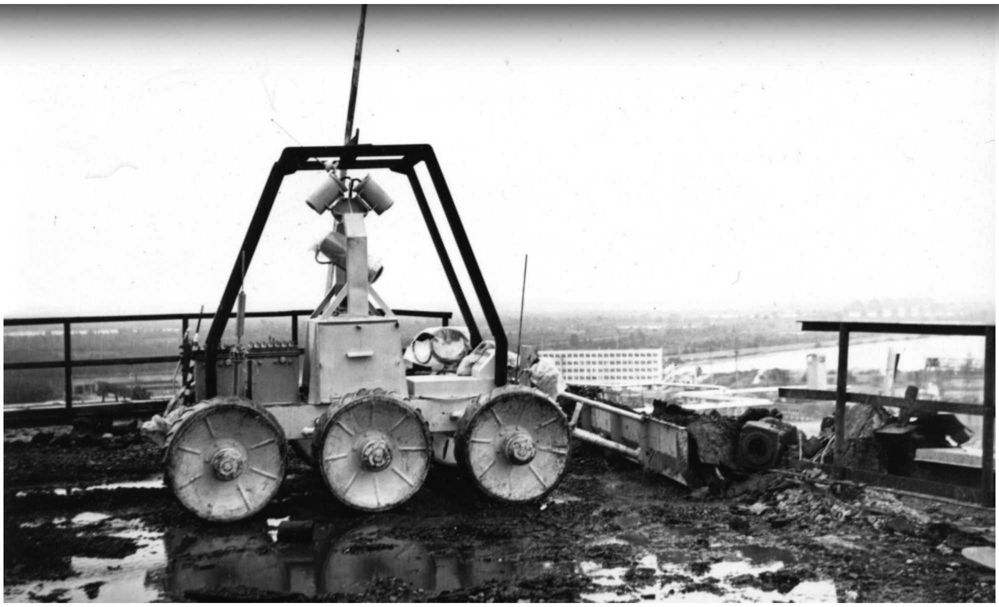


The biggest obstacle to the Sarcophagus’ construction were untold thousands of shattered graphite chunks ejected from the reactor core and thrown up onto the roofs of Unit 3 and the shared chimney. They needed to be removed, but radiation levels on top of Units 3 and 4 - which were too unstable to support the weight of a heavy bulldozer - were far higher than any human could survive.

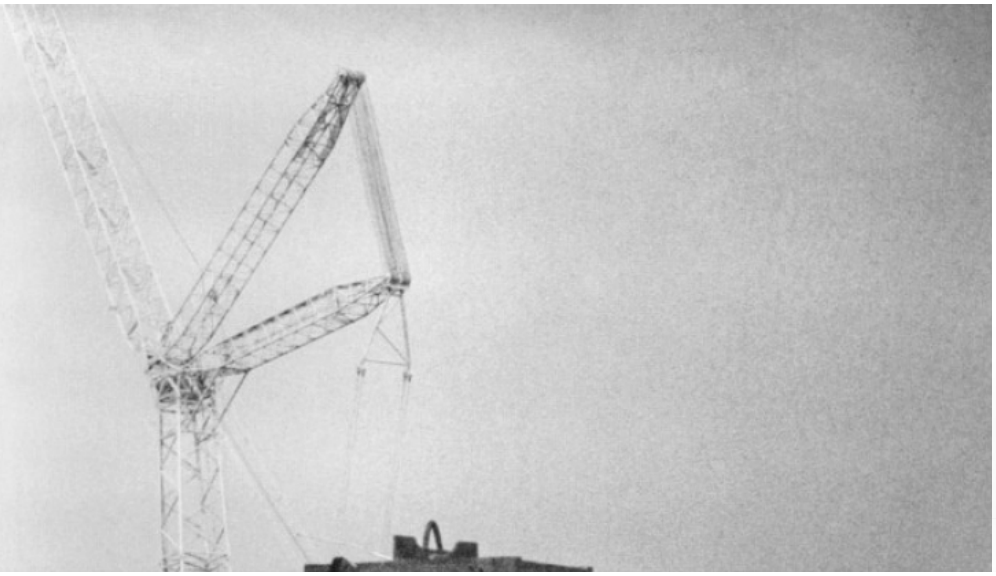
The solution was to airlift remote control robots from across Russia, Germany and Japan, and use them to slowly push rubble off the side of the building. A lot more photographs and info about all the remote machinery used is available here: http://rusdarpa.ru/?p=758

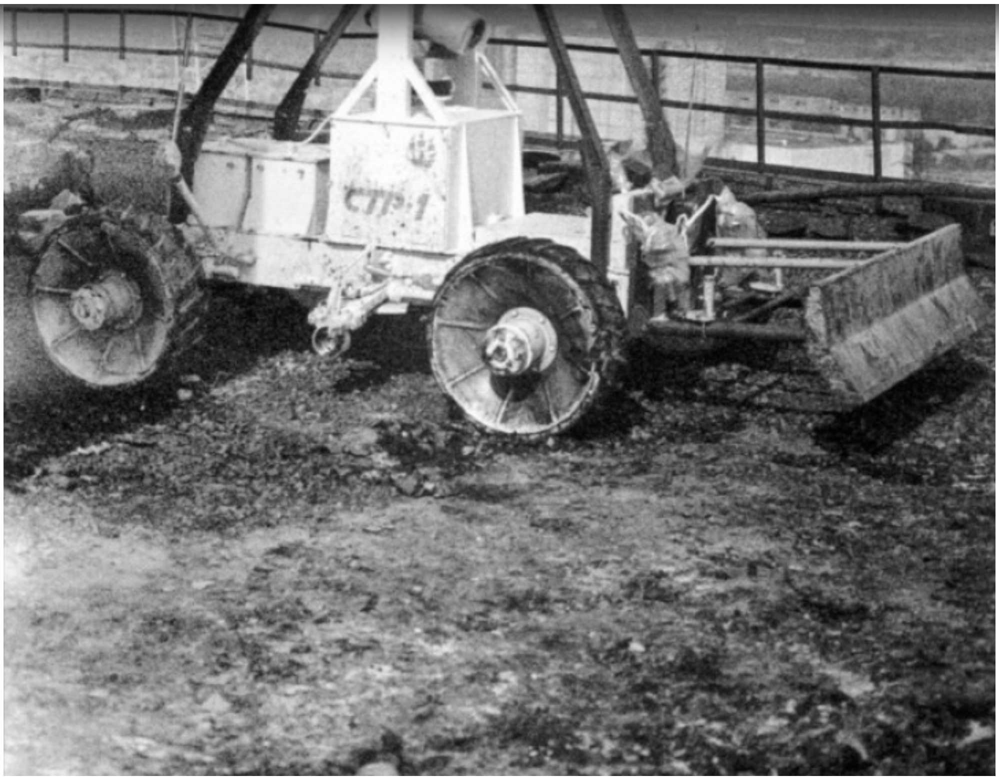
The Chernobyl Story [Updated & Expanded]

By rspc



This included a couple of lightweight, experimental, remote controlled STR-1 robots from the Soviet space program, built to land on the Moon.

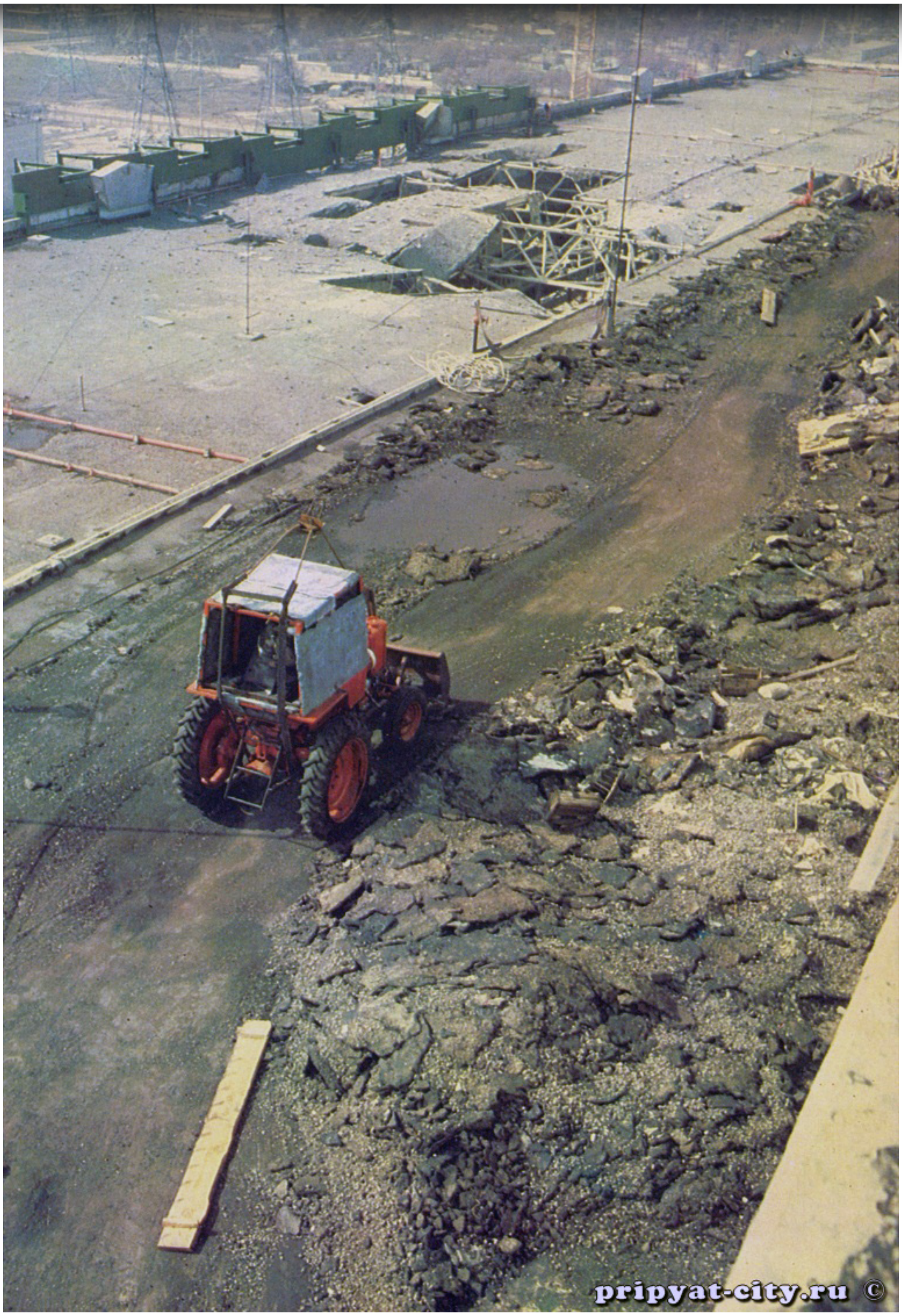




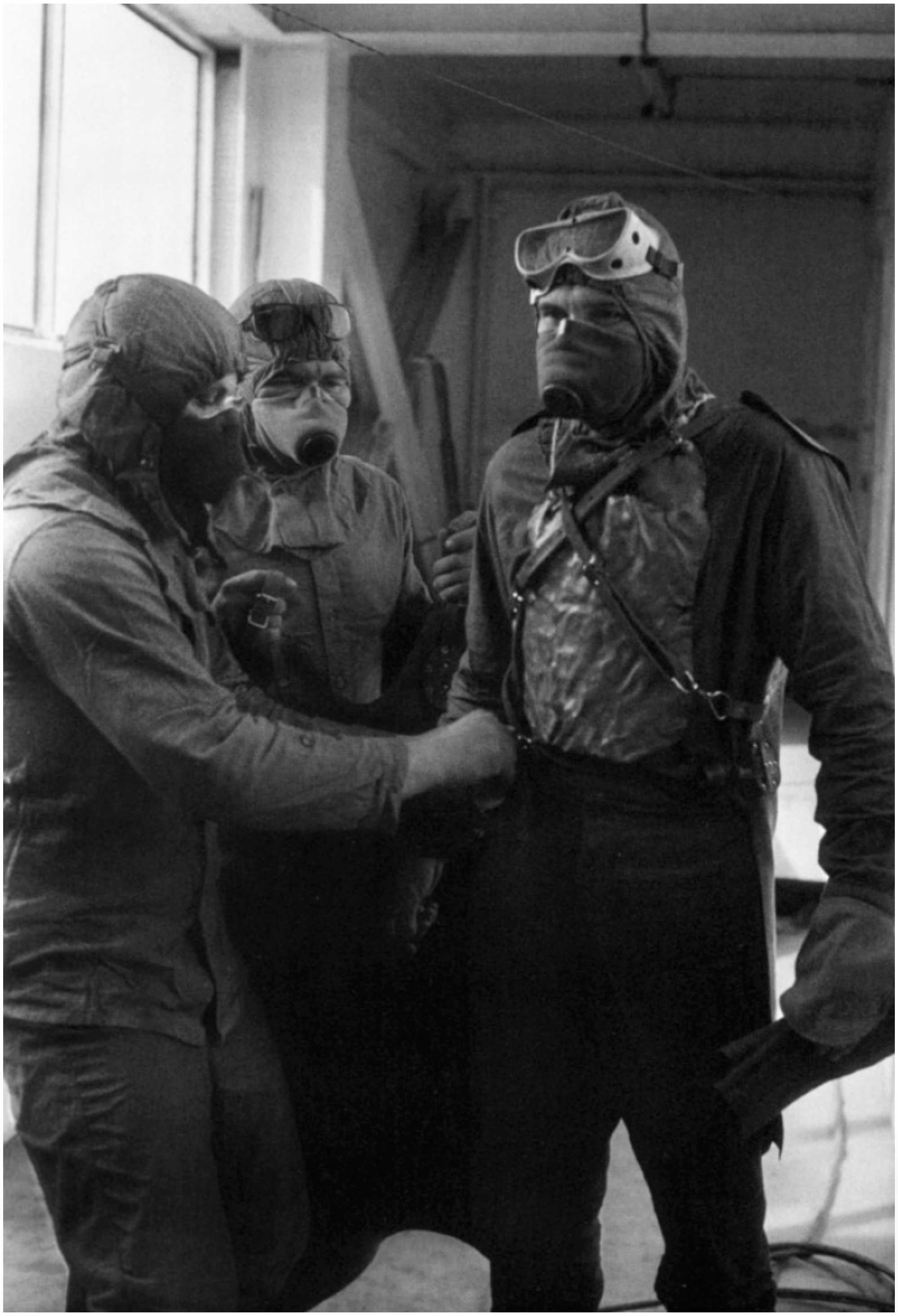
“At the beginning, we thought that in some extremely contaminated zones we would use robots,” wrote Igor Kostin in his 2006 photo-book ‘Confessions of a Reporter’. “We had even sent a very sophisticated German robot to the plant’s roof. But he refused to obey - the radioactivity had disturbed even the machines. Afterward, he rolled over to the edge of the roof and threw himself from the top of the plant. One might have thought he had jumped.” Hardened vehicles like the STR-1 survived the radiation, but then became tangled in the debris.

The Chernobyl Story [Updated & Expanded]

By rspc



on the highest parts of the building.



The Chernobyl Story [Updated & Expanded]

By rspc

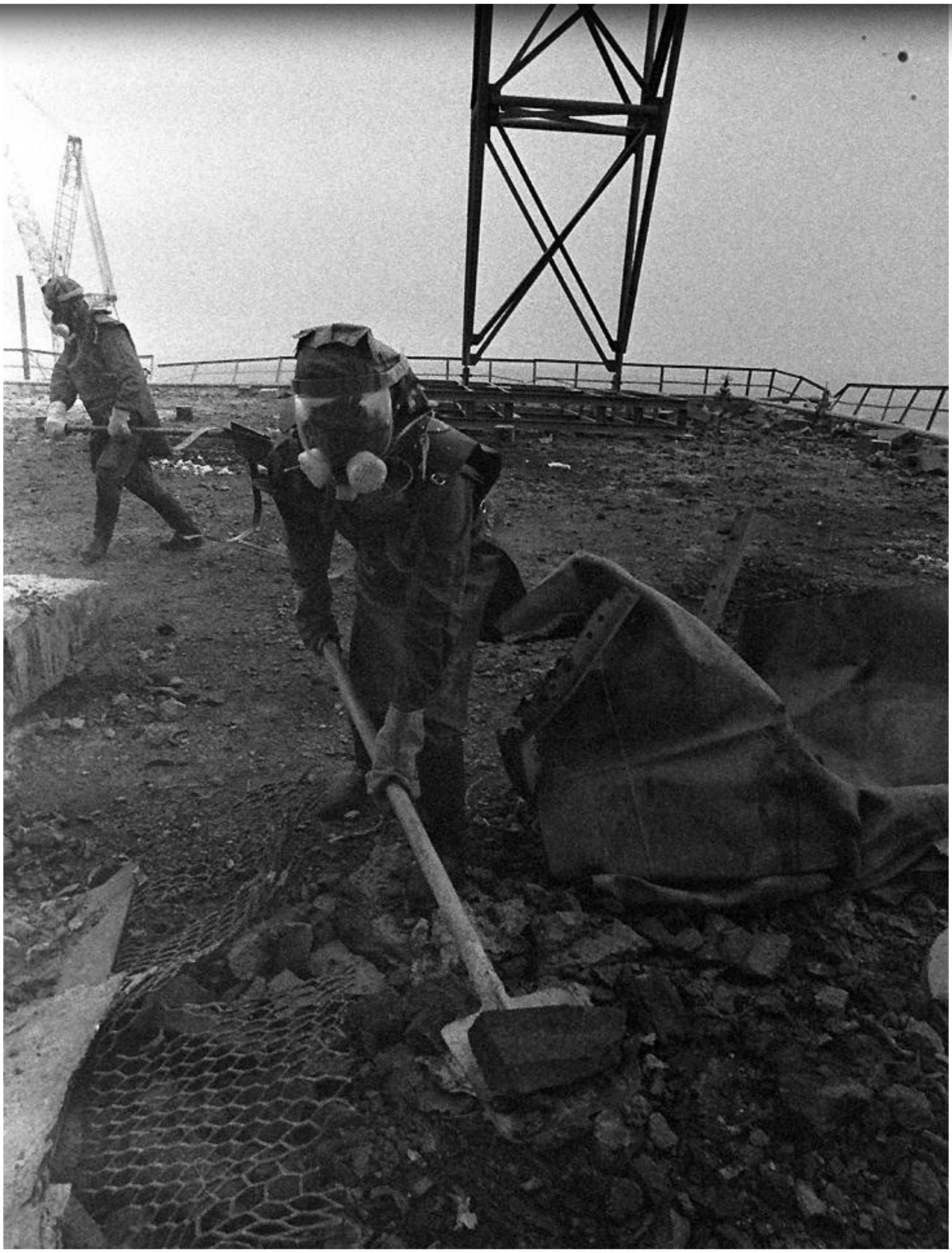
There was no alternative: men would work in an environment so hazardous that even the machines had died. “The best robots,” explains a bitter Nikolai Steinberg, Dyatlov’s predecessor, and the man who took over as plant manager from Bryukhanov, “were people.”

www.magmens.com

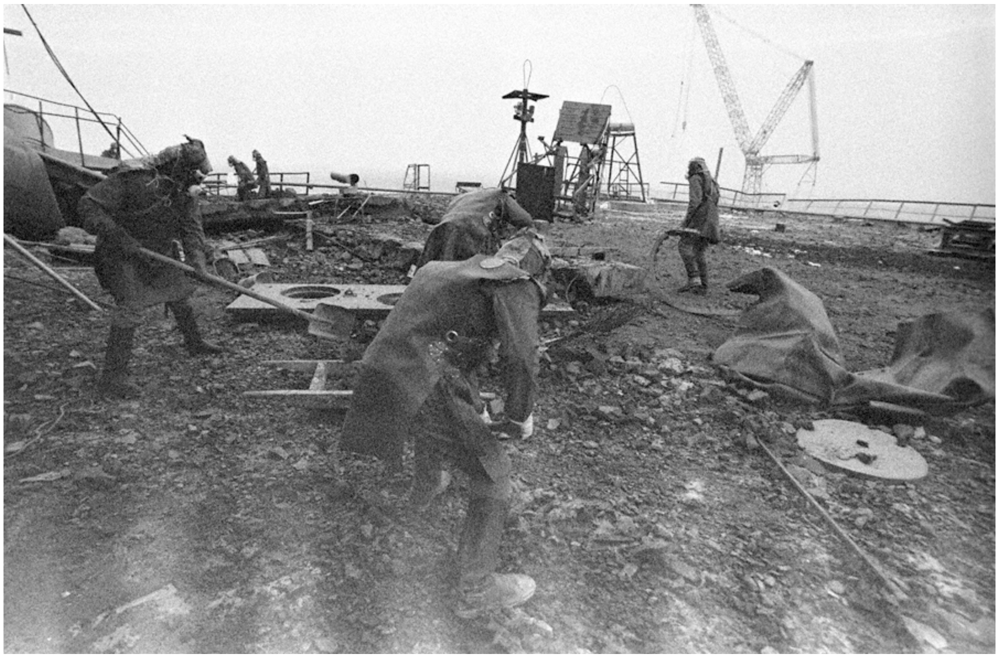
Wearing hand-sewn, lead-plated suits that could only be used once (the lead absorbed too much radiation to be re-used) as their only protection, the men called themselves Bio-Robots.

The Chernobyl Story [Updated & Expanded]

By rspc



Scientists calculated that people could work on the roof for up to 40-60 seconds at a time without receiving a life-threatening dose. During the day, terrified men from all walks of life dashed the rest being done by 5,000 men, according to Yuri Semiolenko, the Soviet official responsible for the decontamination of the plant.

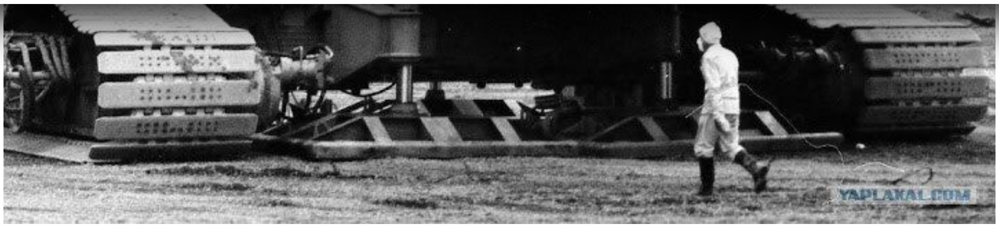


Here you can see the radiation eating into the camera's film from below, although there's some debate about whether this might be a result of badly stored film.

YAPLAKAL.COM

For their sacrifice, the bio-robots received a certificate and a 100 Rouble bonus ($75 US at the time). They allowed work to begin on erecting an enormous enclosure - soon to become known as the Sarcophagus - to seal Unit 4 off from the world. One of the largest and most difficult civil engineering tasks in modern history, there had never been such an important building designed and built in such a short time, under such extreme conditions. It was to stand 170 metres long, 66 metres tall, and envelop the whole of Unit 4.

DEMAG
CC4000



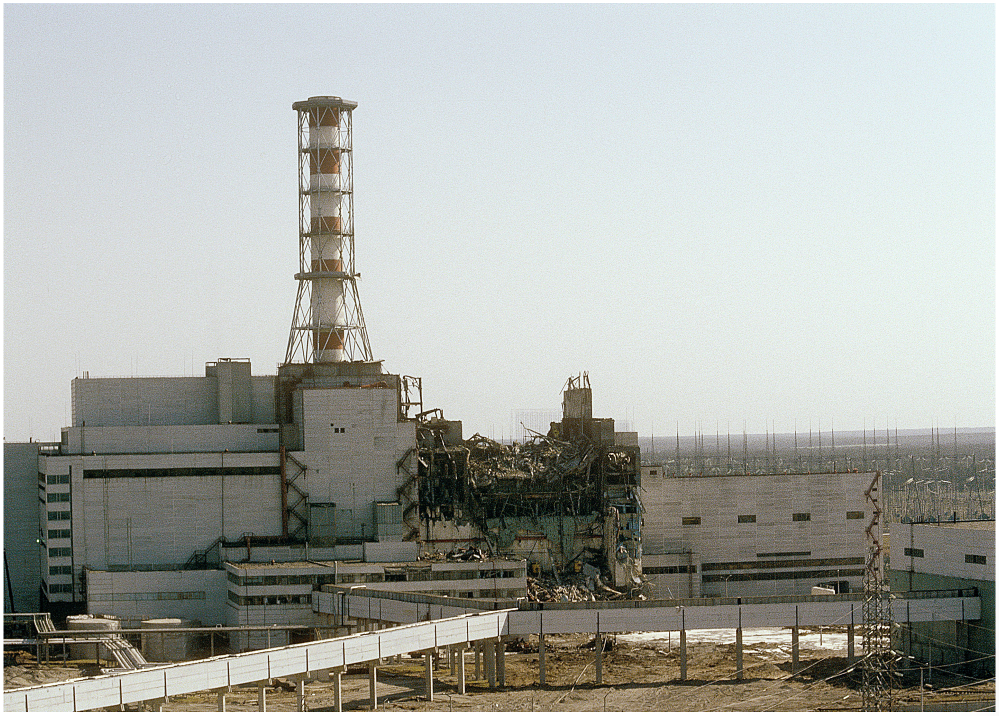
Heavy machinery, specially customised with radiation resistant cabs, like the one seen here and previous, were brought in to help with the construction.

While this was ongoing, pilots flew Mi-26 helicopters (the largest helicopter ever built) around the clock, spraying a special coagulant chemical across the area.

The Chernobyl Story [Updated & Expanded]

By rspc

This sealed radioactive particles to the ground, enabling quick removal and burial. In total, 300,000m^3 of earth was dug up and buried in pits, which were then covered over with concrete.

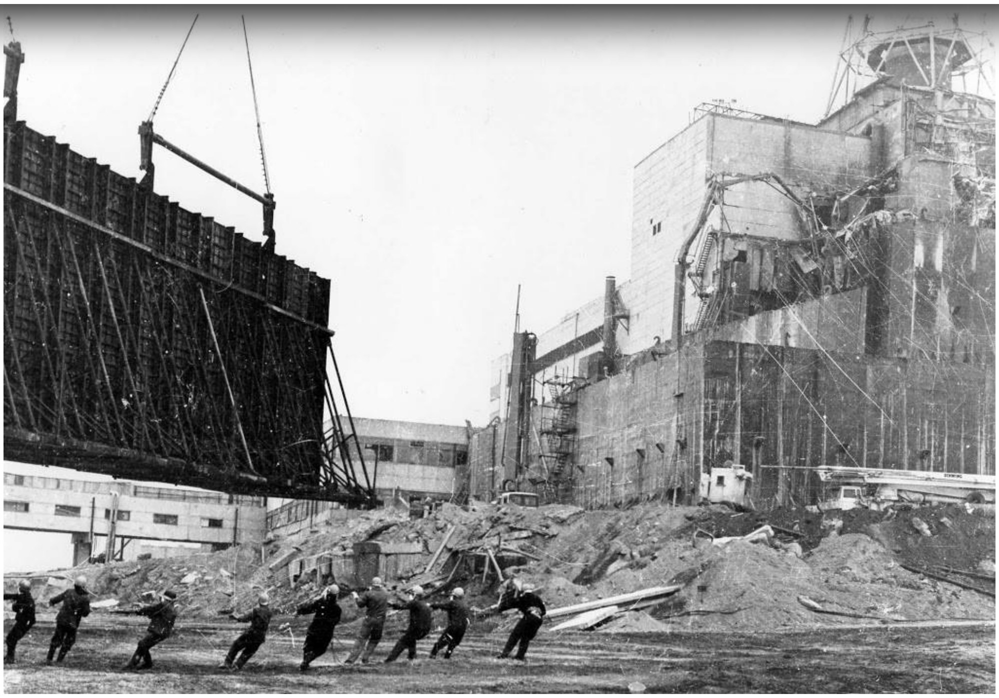


Hunting parties spent weeks scouring the zone and shot all the abandoned family pets, which had begun to roam in packs. It was a necessary evil to avoid the spread of radioactivity, prevent decontamination workers from being attacked, and put the animals out of their misery. A quick death was better than slowly dying of starvation and radiation sickness.

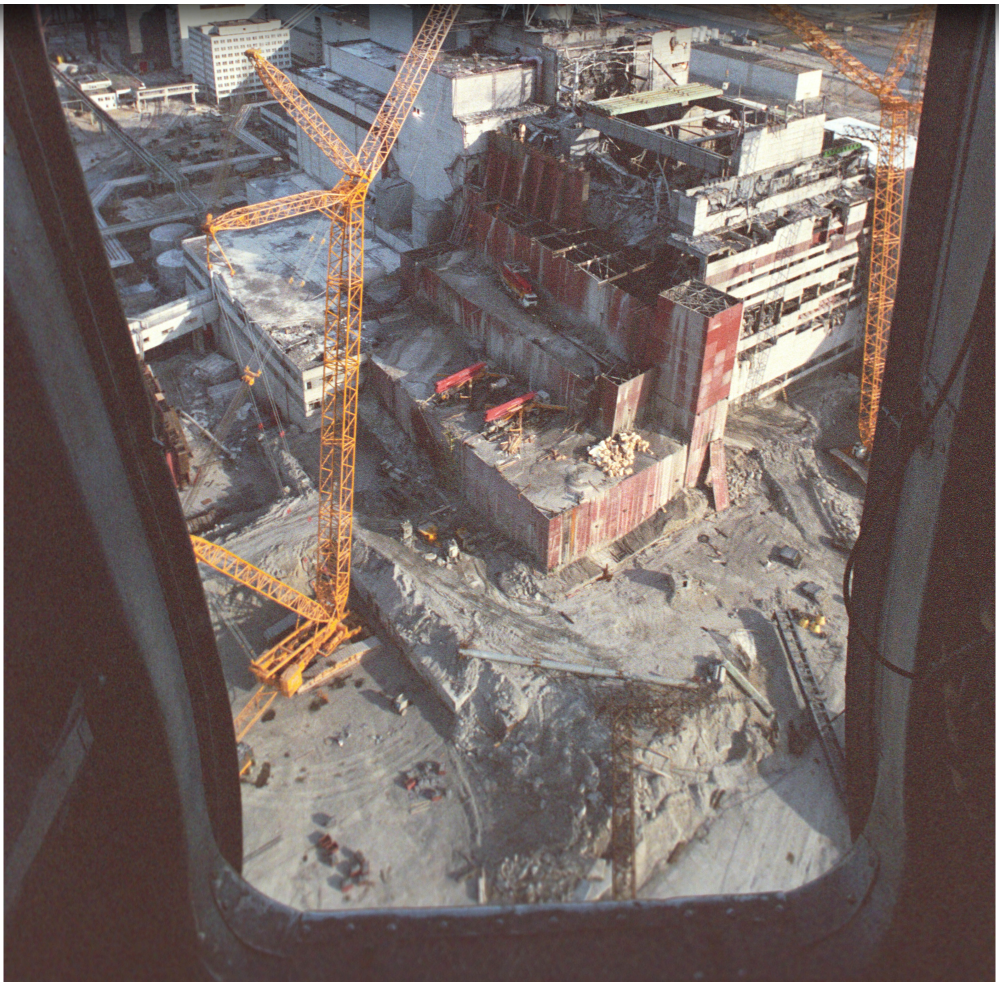
“The first time we came, the dogs were running around near their houses, guarding them, waiting for people to come back”, recounted Viktor Verzhikovskiy, Chairman of the Khoyniki Society of Volunteer Hunters and Fishermen. “They were happy to see us, they ran toward our voices. We shot them in the houses, and the barns, in the yards. We’d drag them out onto the street and load them onto the dump truck. It wasn’t very nice. They couldn’t understand: why are we killing them? They were easy to kill, they were household pets. They didn’t fear guns or people.”

The Chernobyl Story [Updated & Expanded]

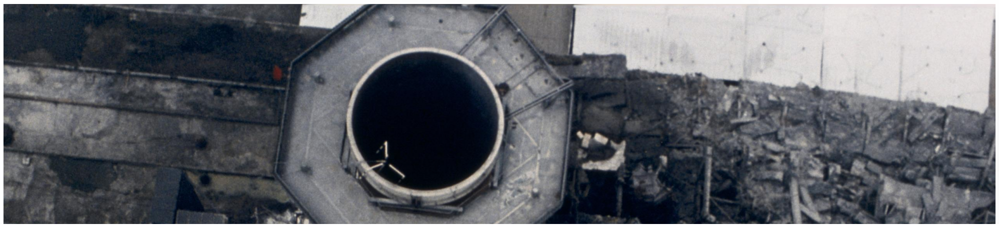
By rspc



The Sarcophagus needed the strength to withstand Ukrainian weather for an estimated 20 years - time to develop a more permanent solution - and contain the astronomical levels of radiation within.

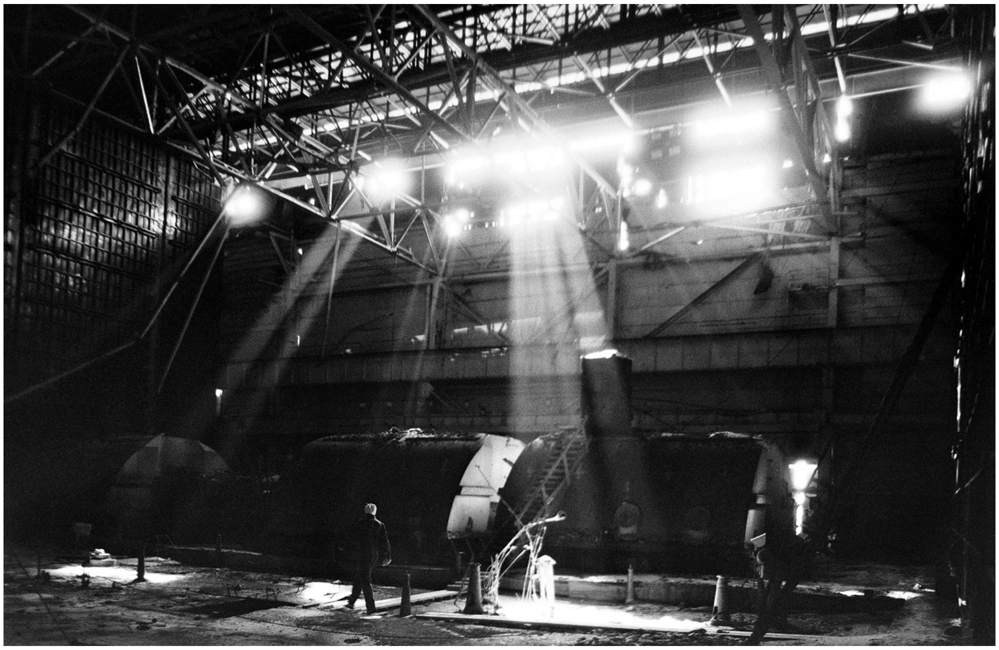


Once people reached their dosage limit, they were paid and sent home.



The Chernobyl Story [Updated & Expanded]

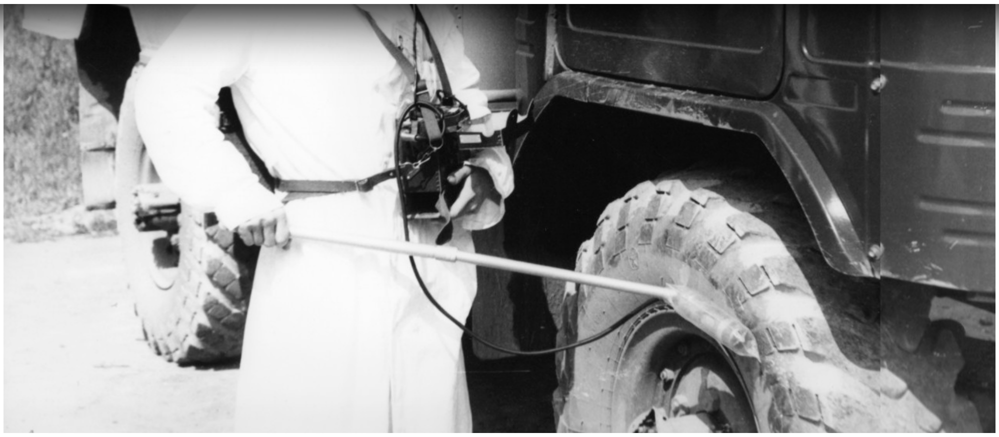
By rspc



This is a view from inside the damaged turbine hall.

The Chernobyl Story [Updated & Expanded]

By rspc



All vehicles entering and leaving the 30km exclusion zone were meticulously cleaned and measured for radioactive particles.

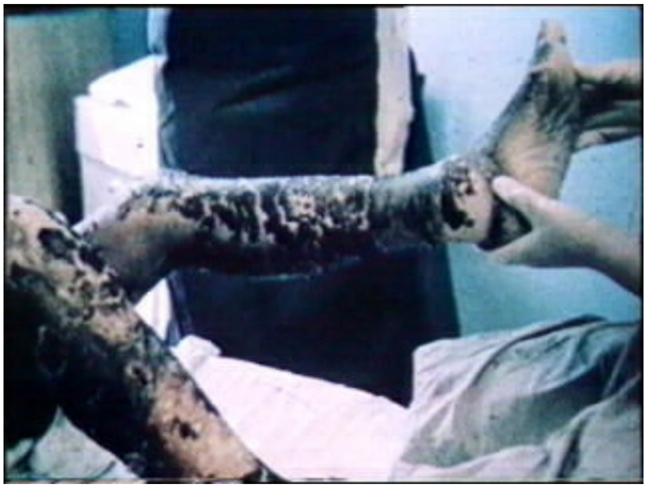
The Chernobyl Story [Updated & Expanded]

By rspc

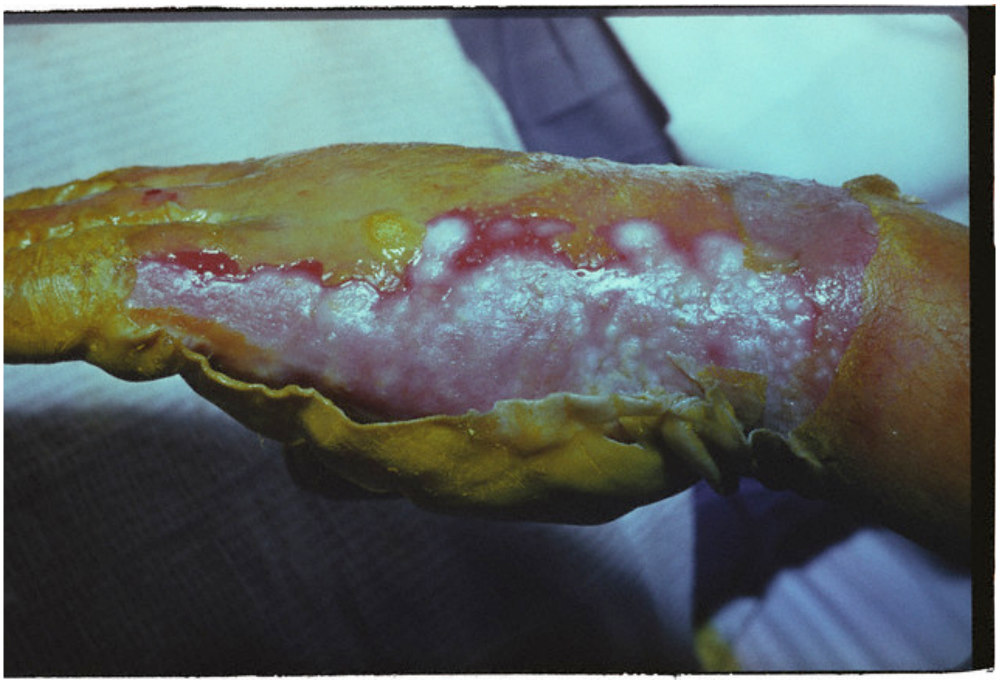
The poor firemen who had first battled the flames on the night of the explosion were dying of radiation syndrome one by one. They had been flown to a specialist radiation hospital in Moscow, called Hospital No. 6

It’s often stated that radiation has no taste, but the men who absorbed the highest doses at Chernobyl all reported a metallic taste in their mouths immediately upon exposure, so it seems that if the dose is high enough to kill you, you will definitely taste it. While every person’s body reacts slightly differently, the following is a good general indicator of the consequences of extreme doses of radiation.

Once exposed, nausea and vomiting will begin almost immediately, and within a short space of time your tongue and eyes will swell, followed by the rest of your body. You'll feel weakened, as if the strength has been drained from you. If you've received a high dose of direct exposure - as in this scenario - your skin will blanche dark red within moments, a phenomenon often called nuclear sunburn. An hour or two after exposure, you'll gain a pounding headache, a fever and diarrhoea, after which you'll go into shock and pass out.



After this initial bout of symptoms, there's often a latent period during which you'll start to feel like you're recovering. The nausea will recede, along with some swelling, though other symptoms will remain. This latent period varies in duration from case to case, and of course it depends on the dose, but it can last a few days. It's cruel because it gives you hope, only to then get much, much worse. The vomiting and diarrhoea will return, along with delirium. An unstoppable, excruciating pain seethes through your body, from the skin down to your bones, and you'll

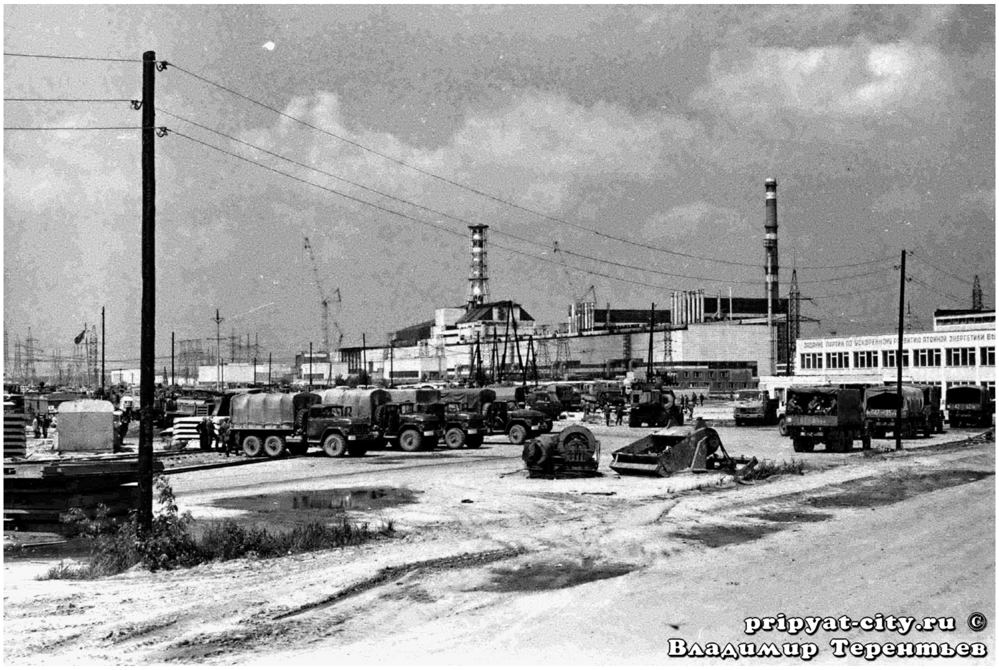


Your bones will rot, forever destroying your ability to create new blood cells. As you near the end, your immune system will completely collapse, your lungs, heart and other internal organs will begin to disintegrate, and you'll cough them up. Your skin will eventually break down entirely, all but guaranteeing infection. One man from Chernobyl reported that when he stood up his skin slipped down off his leg like a sock. At high doses, radiation will change the very fabric of your DNA, turning you quite literally into a person other than the one you were before. And then you'll die, in agony.

The Chernobyl Story [Updated & Expanded]

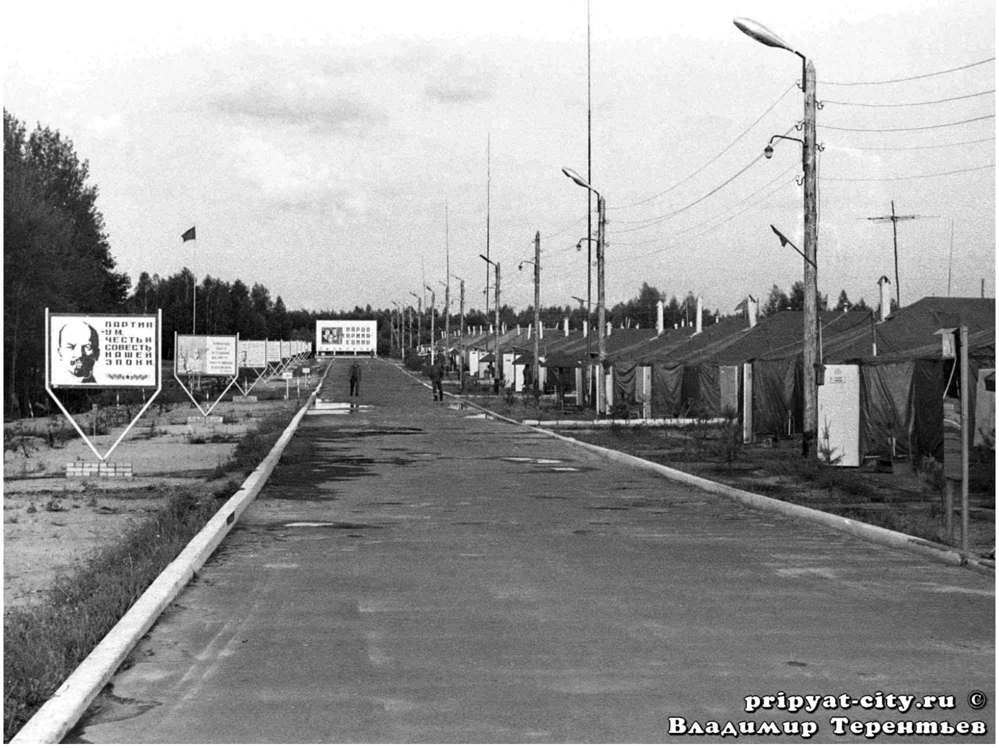
By rspc

The official USSR figures state that 30 men and one female security guard died as a direct consequence of the accident. That list only covers the people who were at the site within the first few hours of the explosion and who quickly died of acute radiation syndrome or burns, and ignores all military personnel (journalists, doctors etc). Those whose bodies were recovered are buried in welded zinc coffins, to prevent their radioactive remains from contaminating the soil.



The Chernobyl zone had by now transformed into a huge clean-up operation, involving hundreds of thousands of people, who came to be called Liquidators.

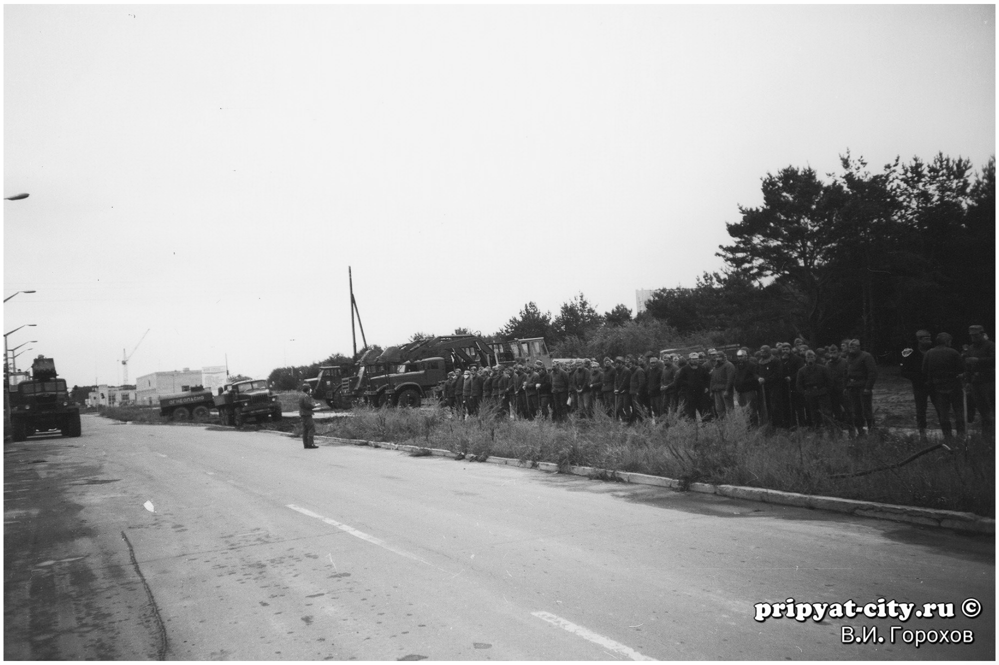
Passenger ships were sailed up the Dnieper River and moored nearby, to provide accommodation for the more lucky and higher ranking Liquidators.


ПАРТИЯ — УМ, ЧЕСТЬ И СОВЕСТЬ НАШЕЙ ЭПОХИ.
pripyat-city.ru ©
Владимир Терентьев

The less fortunate were billeted in vast fields of tents, a few kilometers from the plant.

pripyat-city.ru ©
В.И. Горохов

One of their tasks was to dig up and replace all of the topsoil in Pripyat.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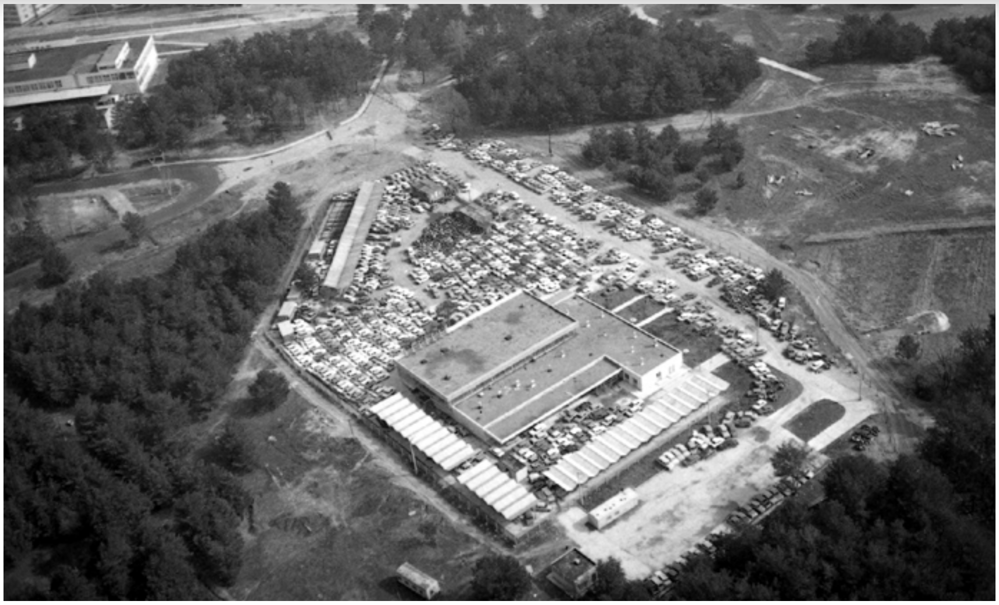
The Chernobyl Story [Updated & Expanded]

By rspc



The cars from the city were gradually buried in vast pits of other radioactive machinery.

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В.И. Горохов

The Chernobyl Story [Updated & Expanded]

By rspc

architecxp © www.pripyat-city.ru

Liquidators wore inadequate protective clothing throughout the entire clean-up operation, which was of particular concern to those working near Chernobyl itself. Most were assigned just three sets of clothing, and were then expected to wear the same three sets for six months.

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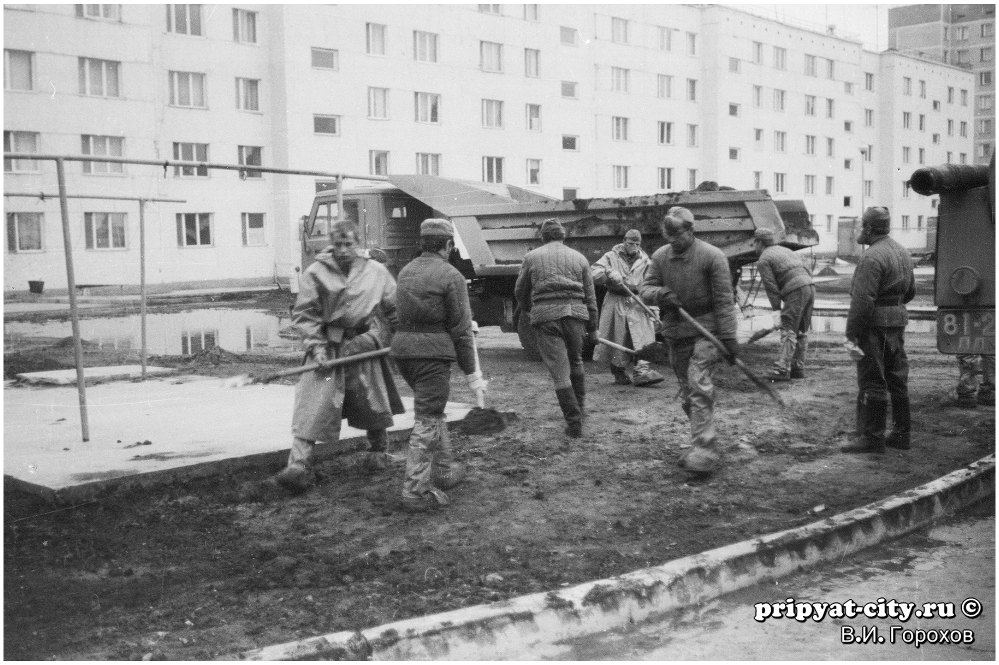
В.И. Горохов

Others exhibited a rather care-free attitude towards their own future health. “Our protective gear consisted of respirators and gas masks, but no one used them because it was 30°C outside”, says Ivan Zhykhov. “If you put those on it would kill you. We signed for them, as you would for supplementary ammunition, and then forgot all about it.”



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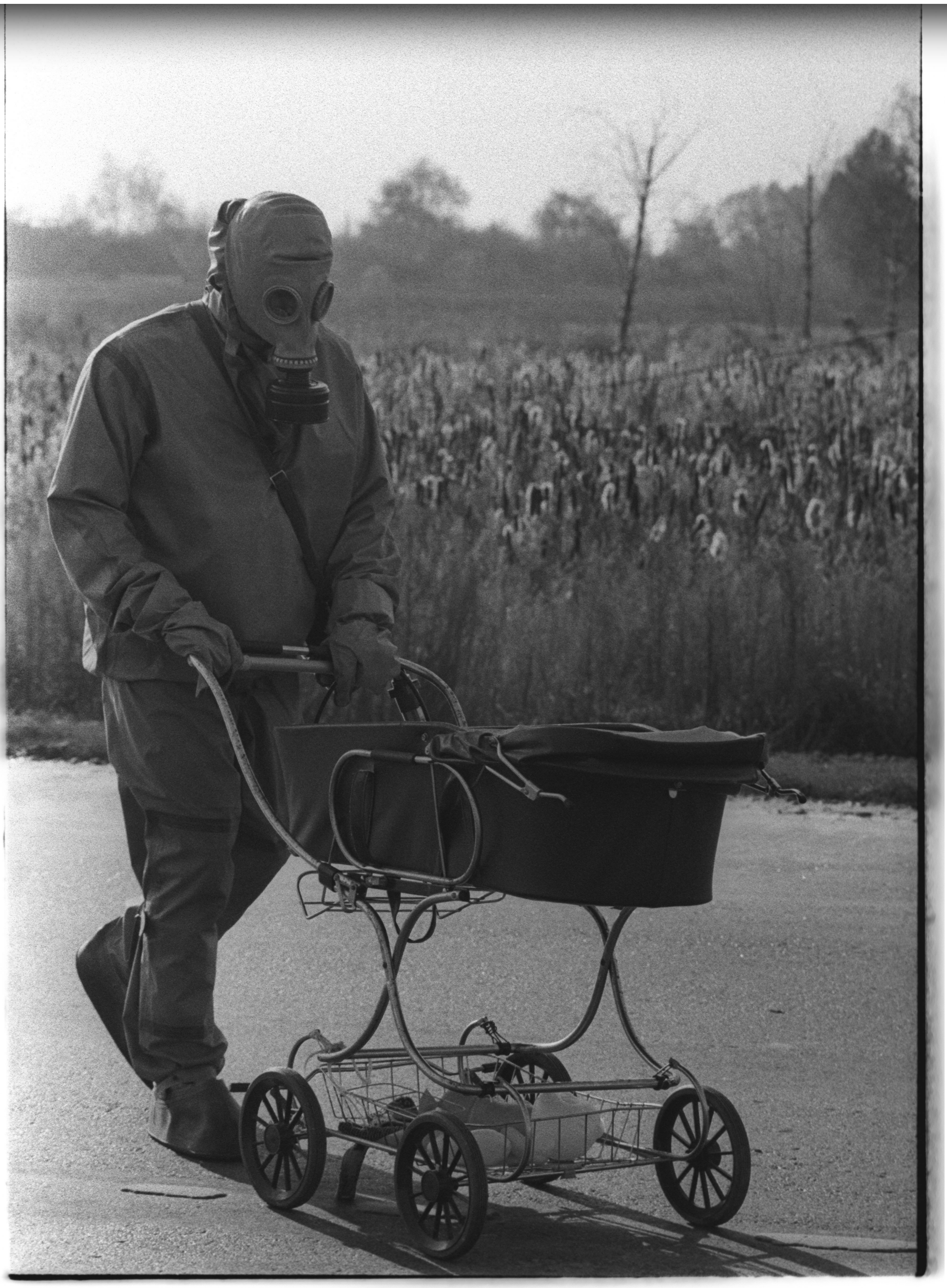
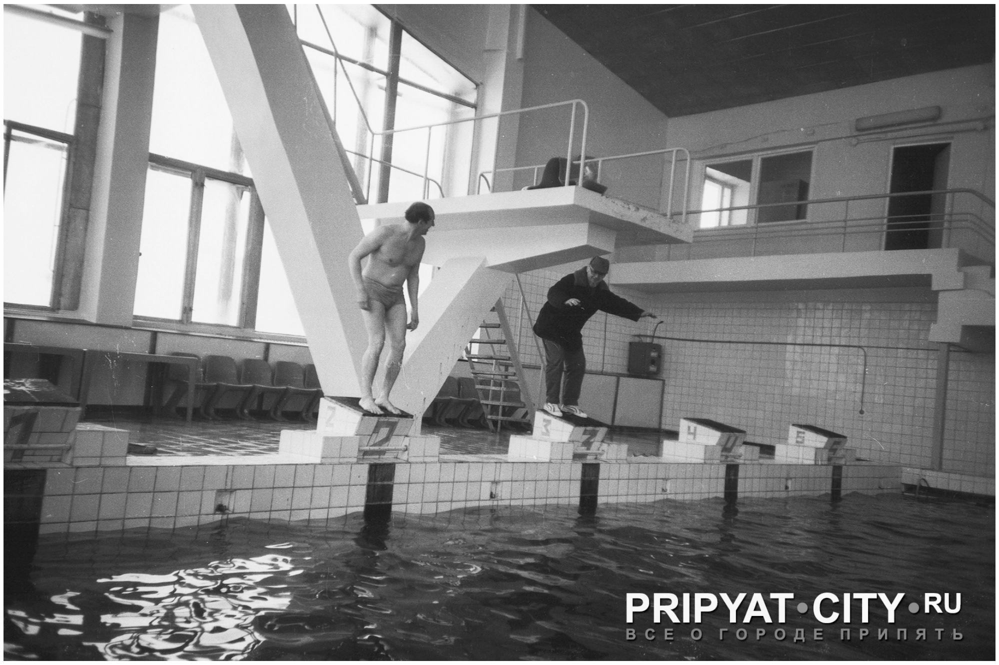
The Chernobyl Story [Updated & Expanded]

By rspc



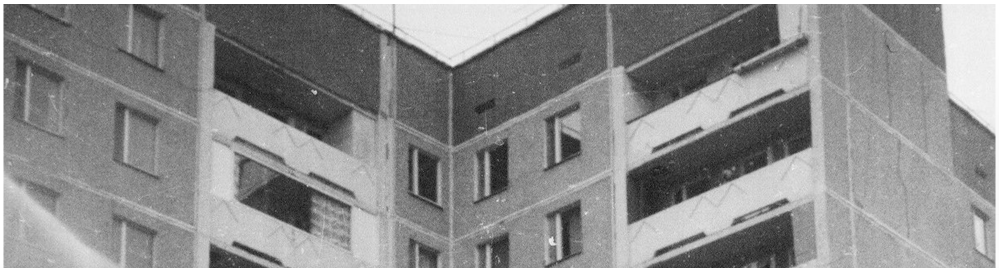
This is a famous shot taken by Igor Kostin, of a Liquidator who apparently discovered a baby abandoned in a country home,


PRIPYAT•CITY•RU
ВСЕ О ГОРОДЕ ПРИПЯТЬ

The swimming pool was deliberately kept open to provide some stress-relief and relaxation for the workers.

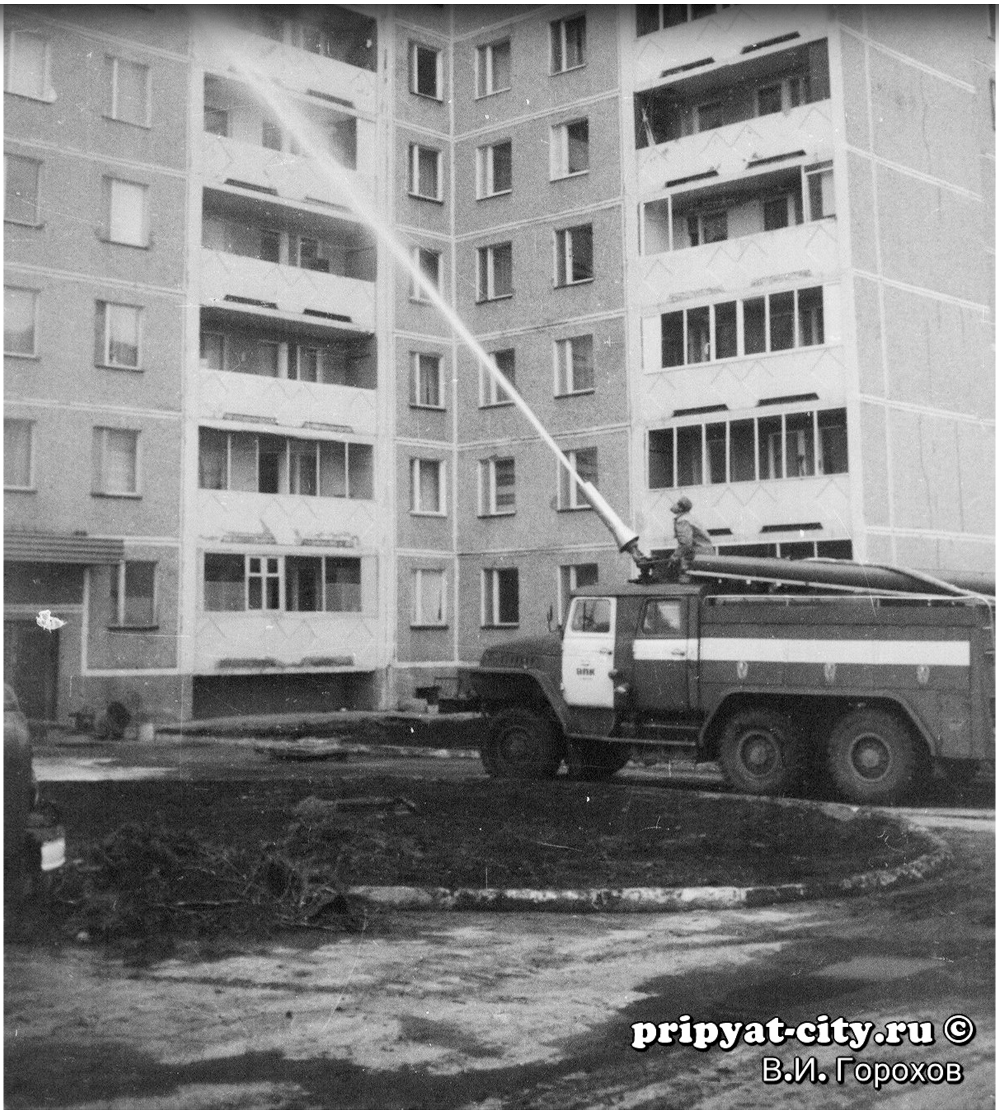
The Chernobyl Story [Updated & Expanded]

By rspc



The Chernobyl Story [Updated & Expanded]

By rspc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Everything had to be cleaned.

The Chernobyl Story [Updated & Expanded]

By rspc

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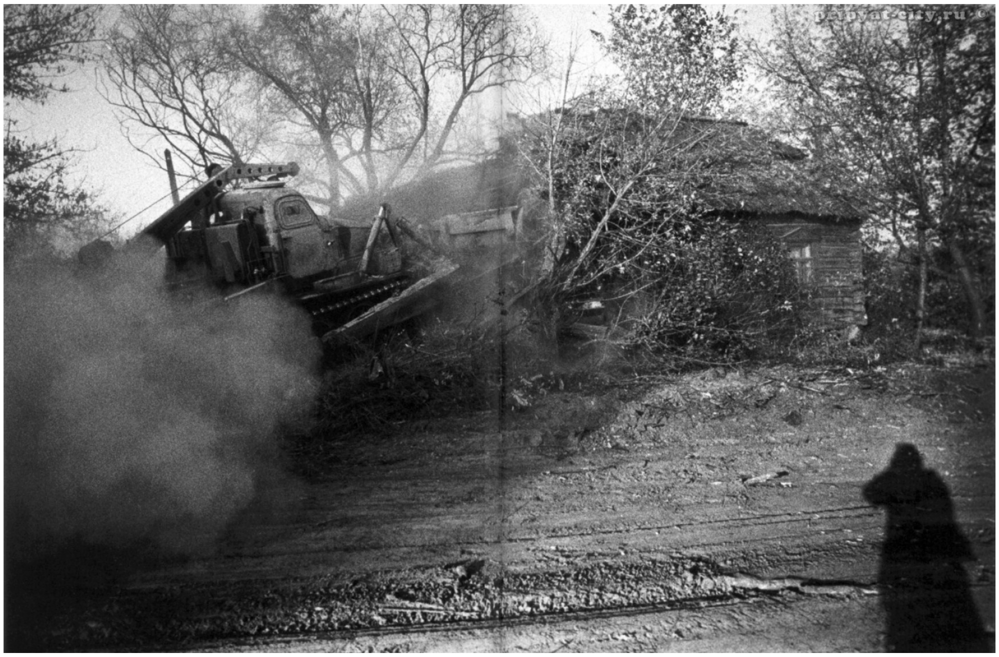
The work took months. To make matters worse, each time it radioactive clouds above.

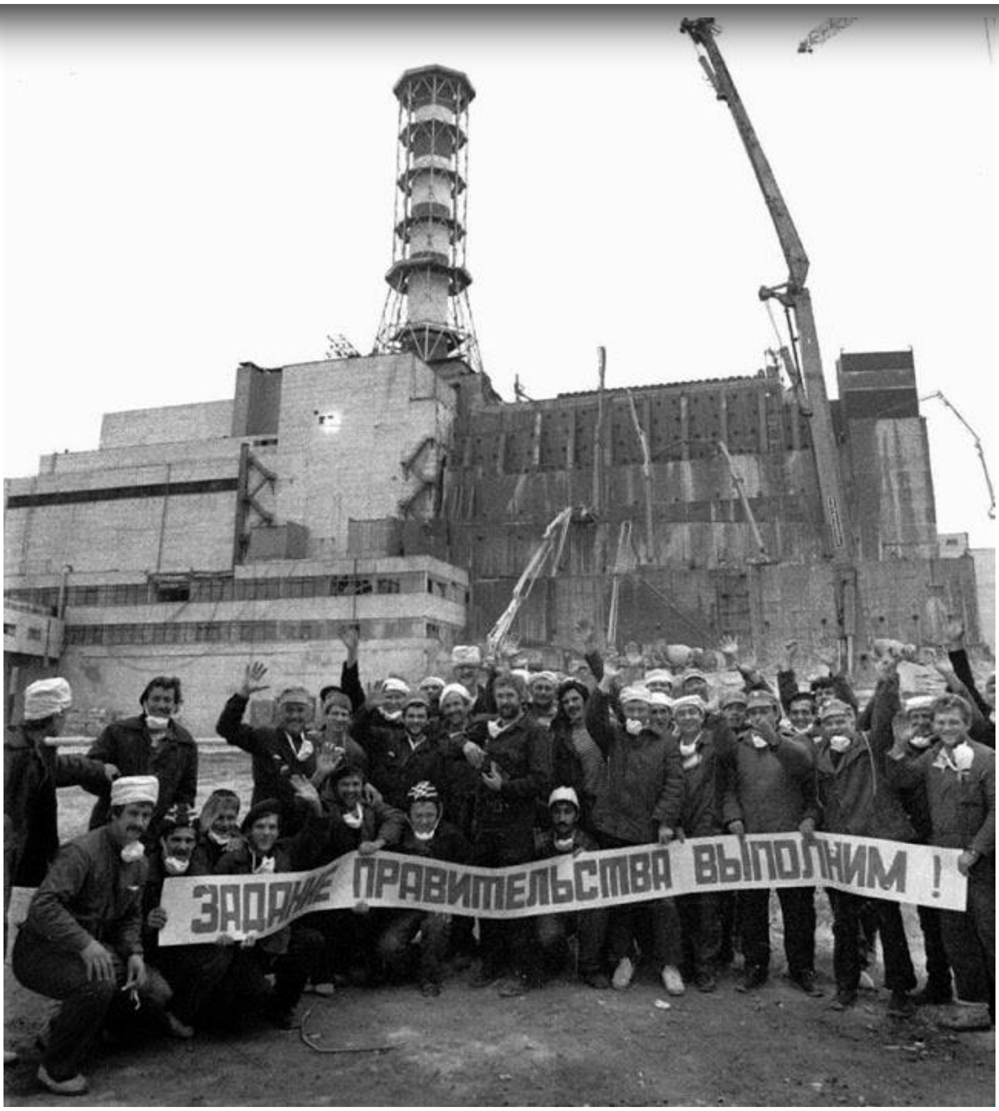
PRIPYAT·CITY·RU
ВСЕ О ГОРОДЕ ПРИПЯТЬ

ПАРТИЯ ЛЕНИНА
СИЛА НАРОДН
НАС
К ТОРЖЕСТВУ
КОММУНИЗМА

By the end of 1986 more than 600 villages and towns in the region had been decontaminated.



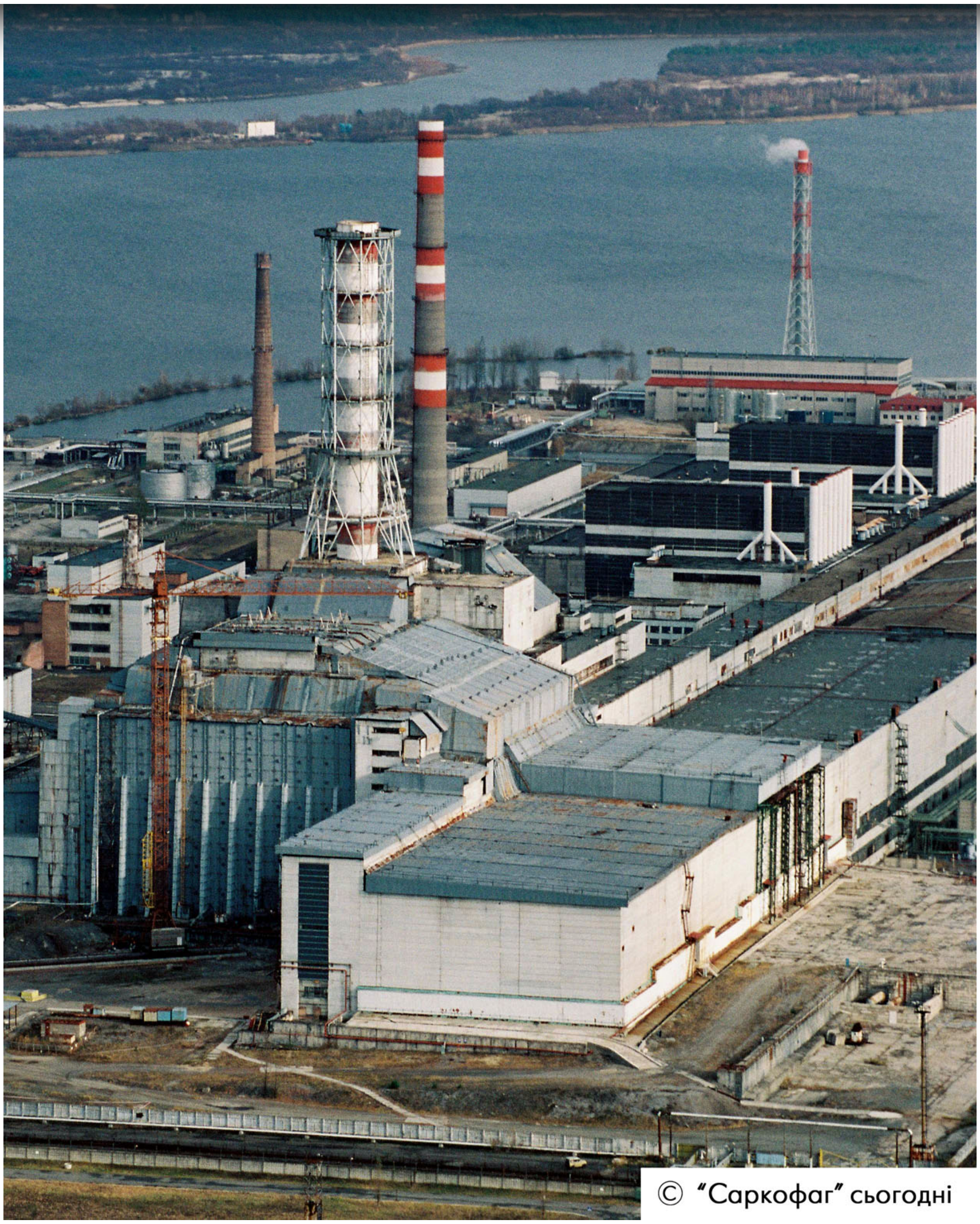
Those that couldn't be properly decontaminated were simply buried.


ЗАДАНИЕ ПРАВИТЕЛЬСТВА ВЫПОЛНИМ !

By this time, the construction of the Sarcophagus was completed.

The Chernobyl Story [Updated & Expanded]

By rspc



© "Саркофаг" сьогодні

More than 400,000m^3 of concrete and 7,300 tons of steel were used during 206 days of construction, which concluded in late November 1986.

The Chernobyl Story [Updated & Expanded]

By rspc

A big test came that winter. If the snow on top of the reactor building melted, they had a big problem. It didn't.

pripyat-city.ru ©
ЗАПРЕТНАЯ ЗОНА

remains so today.

For six months following the accident, as the Sarcophagus was under construction, a team of courageous scientists from the Kurchatov Institute of Atomic Energy re-entered Unit 4 as part of an investigation aptly named Complex Expedition.

ОПАСНО!
406/2
ЦТК
ПИЛОТ
ЦТК
ПИЛОТ

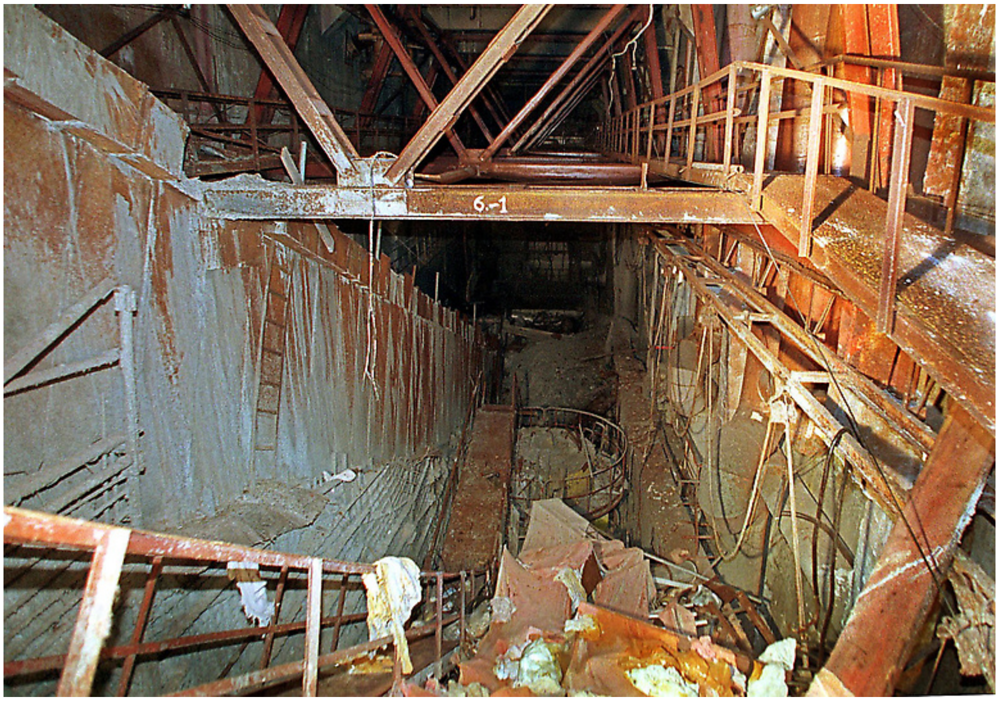
“Everyone was afraid of one thing: an explosion might happen again, because the reactor was out of control” recalls Viktor Popov, the nuclear physicist in charge of the expedition. “Were conditions inside the reactor such that another catastrophe might occur?”

They explored the plant's ruined and unpowered sub-levels with flashlights and cotton masks (the picture 2 above this is from later). “At that time,” says Popov, “there were no places in [Unit 4] that were not dangerous, not by normal human standards. We entered fields of 100, 200, 250 roentgens an hour. This kind of situation could crop up unexpectedly. You're walking down a corridor and the levels are not too bad; 1 to 5 roentgens per hour. Then you turn a corner and suddenly it's 500 roentgens! You have to turn and run for it.”

The Chernobyl Story [Updated & Expanded]

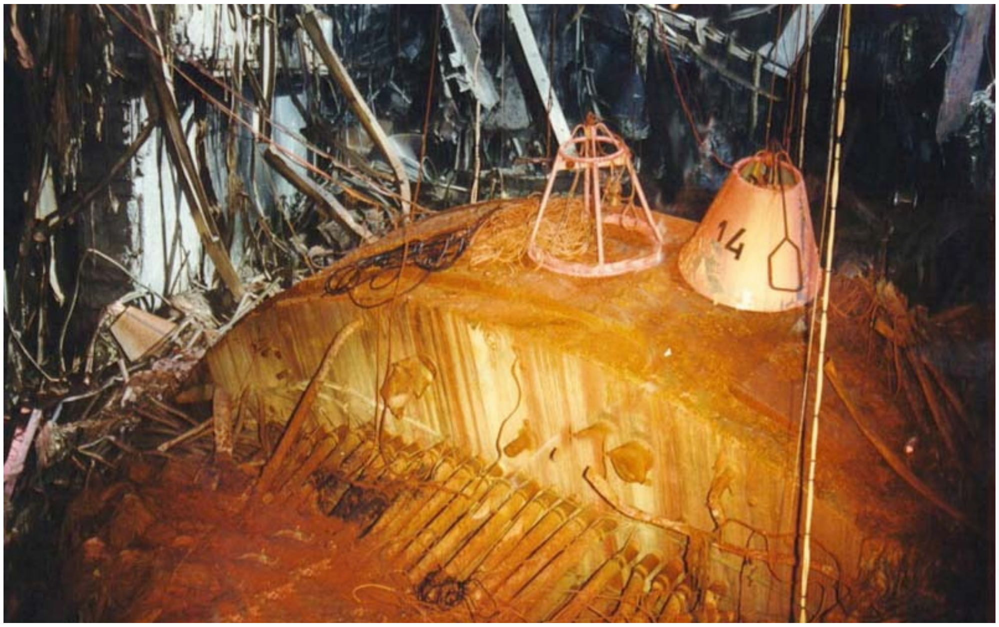
By rspc

In December - six months after the accident - the group of scientists finally found some fuel, with the help of remote cameras poking through a long hole drilled into a wall. It was still emitting extreme radioactivity. “It made us treat it with the utmost respect,” remembers Yuri Buzulukov, another expedition scientist. “To approach it meant certain death.”

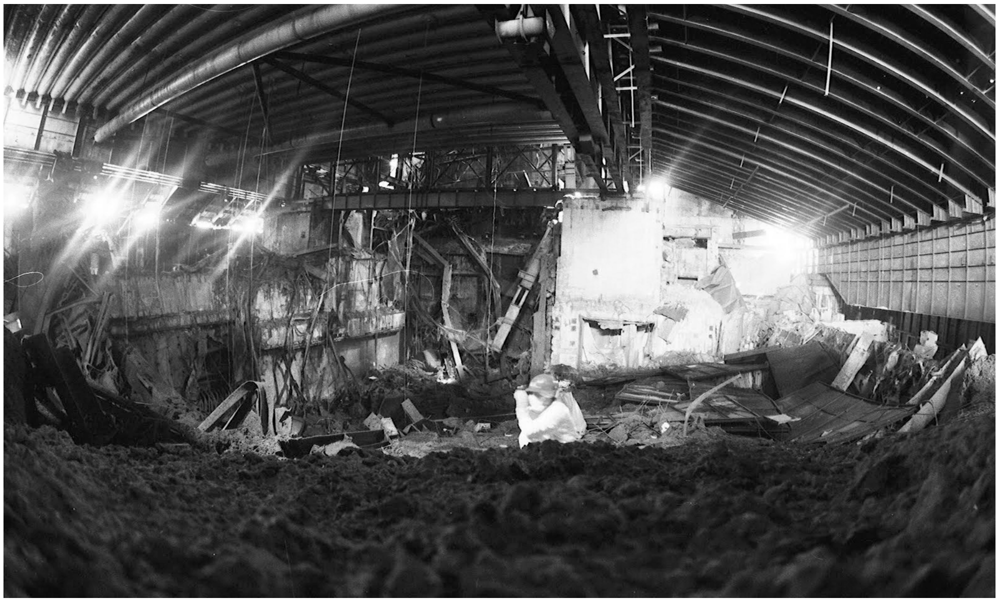


Here you can see the tops of the water pumps poking out of the debris.

The science team next needed a closer look at the reactor itself, so they brought in oil industry engineers to begin drilling through the reactor's reinforced-concrete containment structure. They finally broke through in the summer of 1988, after the end of 18 months of drilling in harsh conditions. "There were many theories about what we might find there," says Buzulukov, "but everyone agreed there would be damaged reactor core: graphite blocks interspersed with distorted fuel rods. But once a hole had been drilled in the side of the reactor vessel, the sight that met our eyes was totally unexpected. The reactor was completely empty."



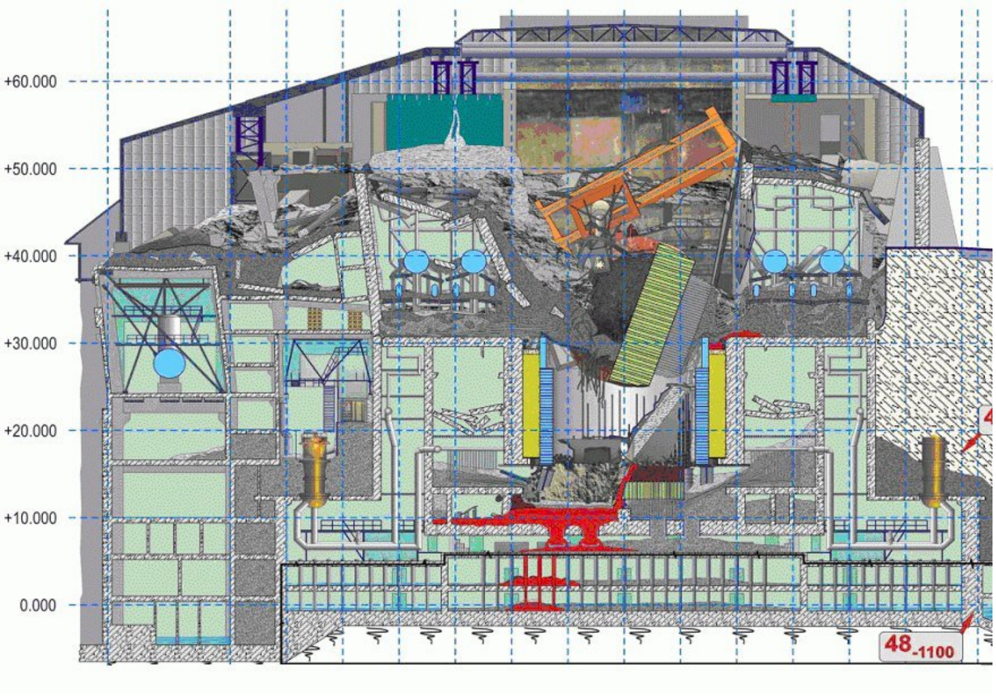
In 1991, the stressed and exhausted members of the expedition realised they had no choice but to venture into the remains of Unit 4’s reactor hall themselves. The risk of a possible second explosion was too great to ignore.



After a treacherous climb over graphite fragments blown out of the reactor and shovelled off the roof, they discovered steaming concrete, heated by the fuel beneath it. Upon closer inspection, they saw radioactive lava - an astonishing find. As the team passed through a narrow, shattered corridor adjacent to the reactor base, their torch-lit dosimeter crackling away at an alarming 1,000R/h, one man noticed that the lower biological shield had crushed the wall beneath it. The final missing piece of the puzzle fell into place.

This is what had happened on that fateful morning: the explosion that blew off the reactor lid also dislodged special serpentine sand and concrete from within the thick walls surrounding the RBMK. In that same moment, a powerful shockwave forced the entire bottom half of the core assembly - including the lower biological shield - downward by several meters into the space below.

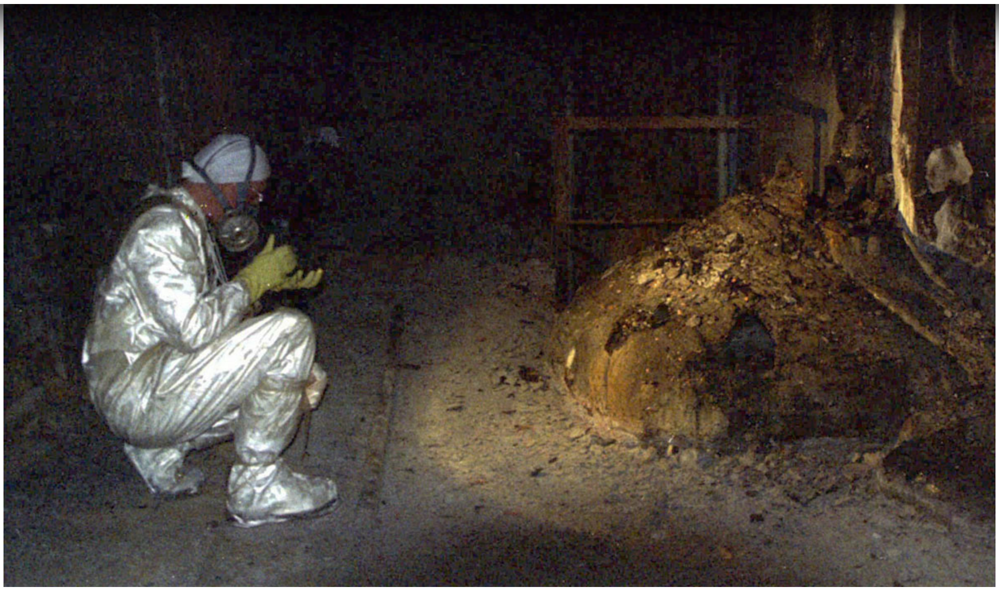
Over the following week, intense heat from the fire and radioactive decay gradually increased until it reached temperatures sufficient to melt the fuel assembly, which poured out and bonded with the sand/concrete mix to form a kind of radioactive lava called corium. This lava then oozed through pipes, ducts and cracks in the damaged structure to the rooms beneath.



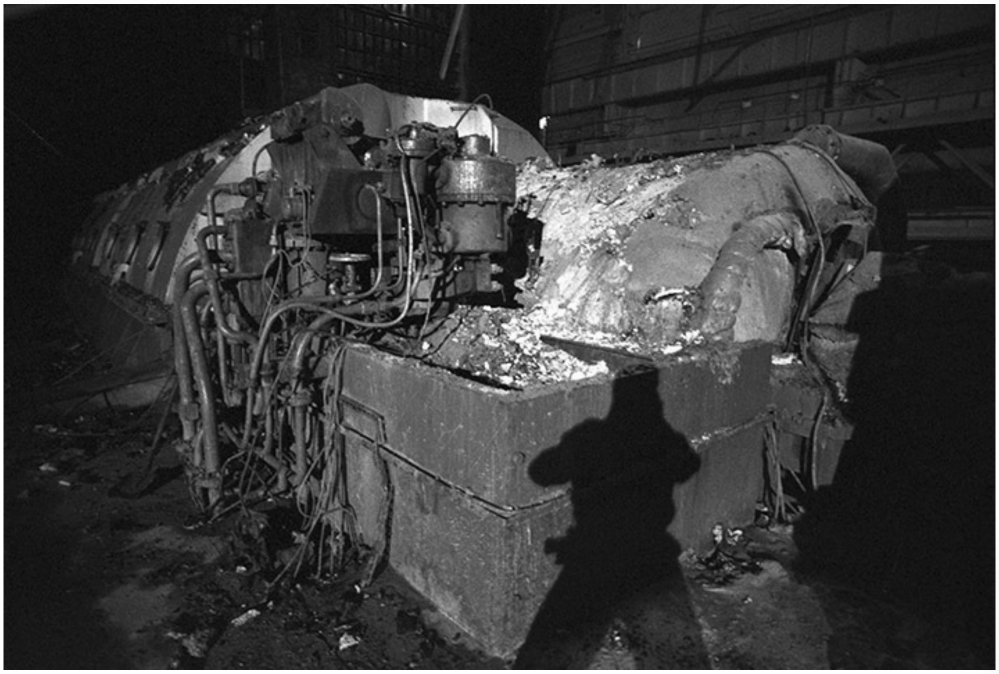
This diagram illustrates the event, showing where the fuel came to rest.

The Chernobyl Story [Updated & Expanded]

By rspc



Artur Korneyev, Deputy Director of the Shelter Object (Sarcophagus), viewing the "elephant's foot" lava flow at Chernobyl, 1996.



The Chernobyl Story [Updated & Expanded]

By rspc

An image of the ruined turbine hall.

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The Chernobyl Story [Updated & Expanded]

By rspc

In 1987, global attention turned to the Soviet elite who faced the task of deciding who would be held responsible for the Chernobyl disaster, and what the appropriate response would be. Six men were put on trial in July, including (from front to back), Bryukhanov (plant manager), Dyatlov (Deputy Chief Engineer, and the man responsible for forcing the test to continue), and Nikolai Fomin, the plant's Chief Engineer.

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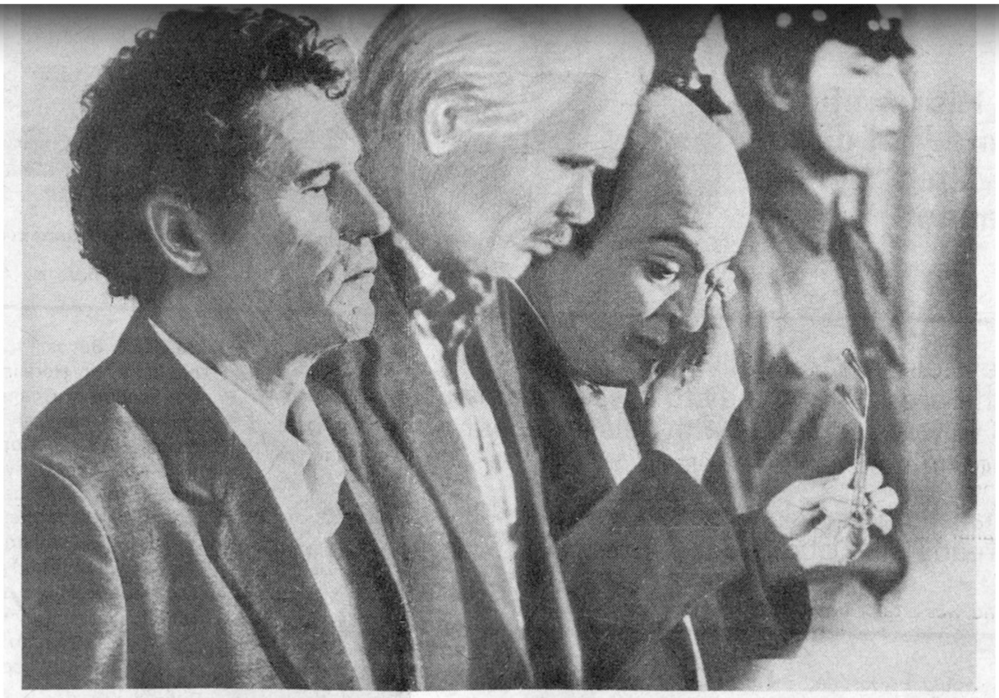
Soviet leaders were supplied information originating from V. P. Volkov, head of the Kurchatov Institute’s RBMK safety research group, which made it very clear that the accident was a result of critical design flaws, but the idea that Soviet reactors were anything less than perfect could never be admitted to the world.

nuclear power, as had occurred in America after Three Mile Island.

The Chairman of the panel of judges had no interest in hearing about defects of the reactor. Scherbina and Legasov’s original government commission had discovered these defects and concluded that the reactor was at fault, but the only sections of their report given any credence by the judges were those criticising the operators. So-called ‘independent experts’ were, in fact, hand-picked men from the various Institutes responsible for the reactor’s creation in the first place - the very same men who had a vested interest in seeing their work exonerated.



Listening to the verdict are the Chernobyl plant's former director, Bryukhanov, deputy chief engineer Dyatlov and the chief engineer Fomin.

Photo by Igor KOSTIN

All six men were found guilty and sent to prison. Bryukhanov and Dyatlov were released early due to poor health. Chief Engineer Nikolai Fomin was declared insane in 1990, and transferred to a psychiatric hospital. Astonishingly, after he recovered he was allowed to return to work at the Kalinin Nuclear Power Plant near Moscow.

Legasov took a very strong stance against the official story that the plant's staff were entirely to blame. His resistance ruined his career. With his reputation in tatters, his health ravaged by the radiation he absorbed at Chernobyl, his disillusionment with his country’s unwillingness to focus more on safety, and feeling the weight of so many dead on his shoulders, he hanged himself on the second anniversary of the disaster - the day after his proposal for a reformed Soviet scientific community was rejected.

ДВОРЕЦ КУЛЬТУРЫ
КПСС
XXVII
КПСС

pripyat-city.ru ©
Станислав Константинов

ГОТЕЛЬ ПОЛІССЯ
НАРОД И ПАРТИЯ - ЕДИНЫ
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Станислав Константинов

Major changes were made to the RBMK design, including improving the speed at which control rods entered the core during a SCRAM event, lowering the time for a complete insertion from 18 seconds to 12; reducing the positive steam void coefficient of reactivity, and the effect of reactivity if there was a complete void in the core; installation of a Fast Acting Emergency Protection system, complete with an additional 24 control rods; removing the ability to bypass emergency protection systems while the reactor was at power, and, most importantly, a new control rod layout with a longer boron section and no empty/water section ahead of it. The graphite tip remained.

The Chernobyl Story [Updated & Expanded]

By rspc

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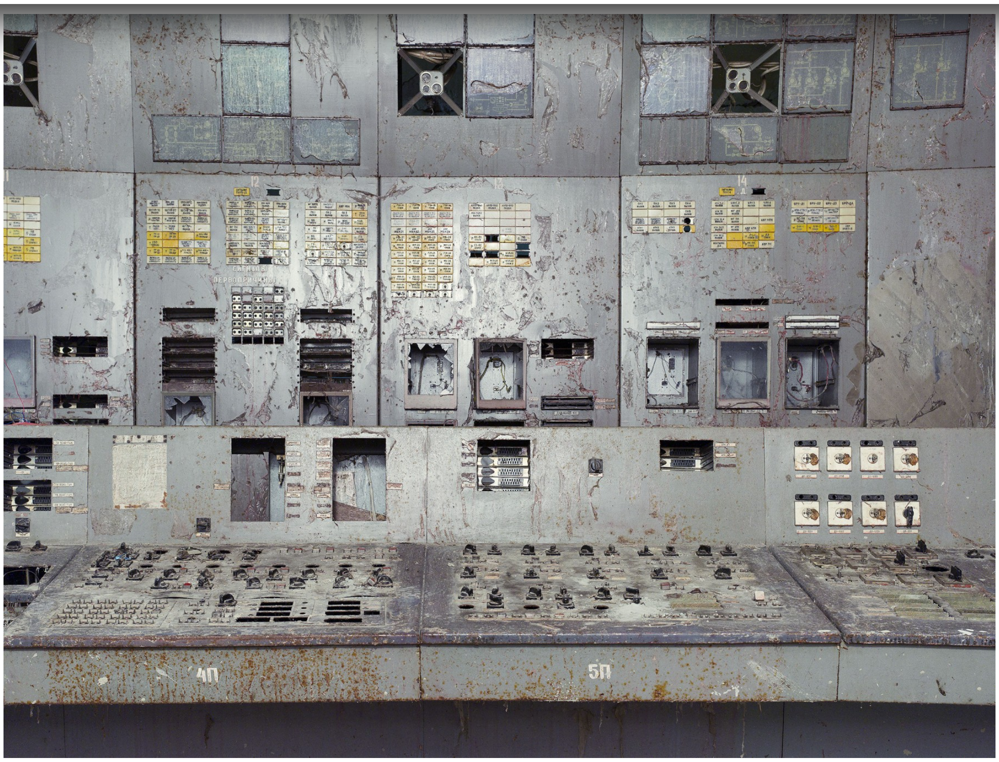
Most new Soviet nuclear plants in the planning or construction stages were either put on hold or cancelled altogether, while new, stricter safety regulations led several existing plants to be shut down for various reasons. By 1989, planned nuclear capacity had reduced by 28,000MWe (for comparison, Unit 4 at Chernobyl produced 1,000MWe and was of the most powerful type of reactor at the time).

development of the RBMK design, beyond maintaining and improving those already in use, and no others not already under construction were ever built. Of the 17 RBMK reactors commissioned, 11 remain in operation today. Since the Chernobyl disaster, the Russian Government has exclusively built VVER reactors - the same type that competed against the RBMK to begin with.

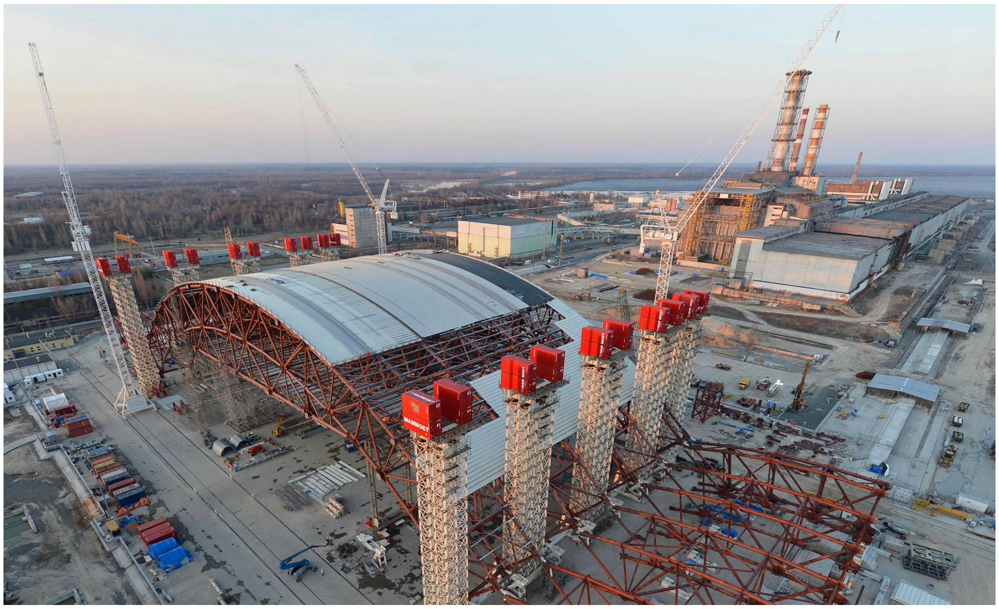
Over the years, animal mutations started to appear - DNA corrupted by the radiation.

pripyat-city.ru ©

None of the machines used during the operation to clean up the zone could ever be used again, as they had become highly radioactive. They lay in vast metal fields for years, before they were gradually taken away and buried in pits.



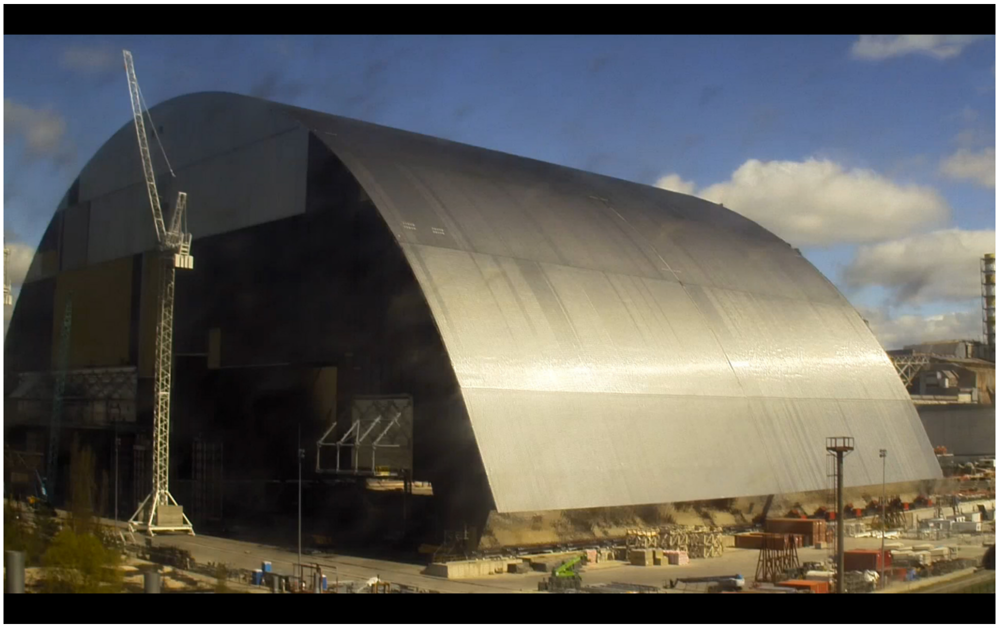
An image of the Unit 4 control console as it appears today.



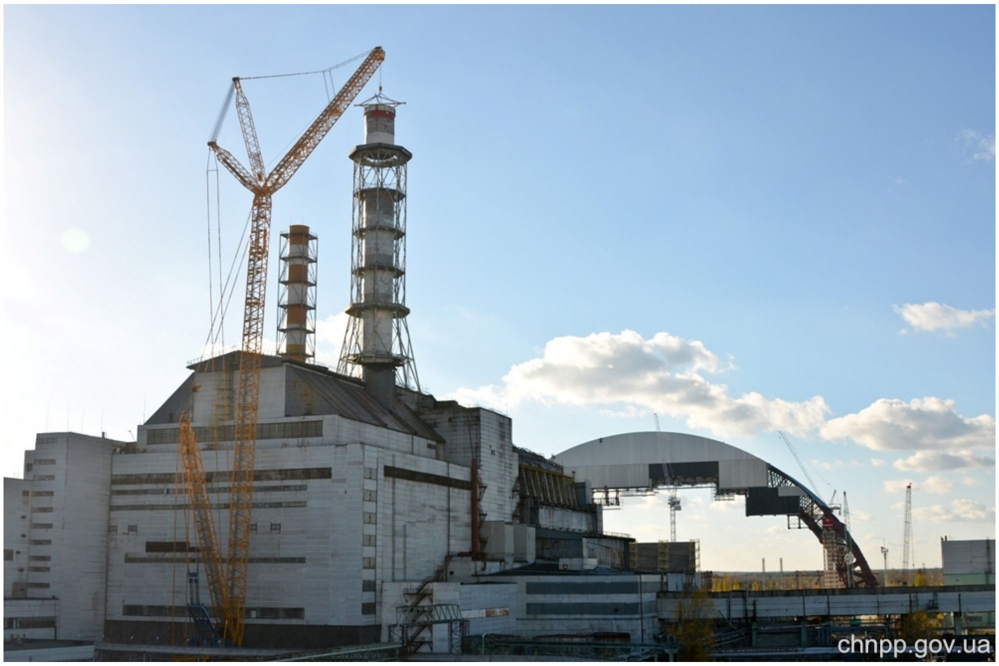
The Chernobyl Story [Updated & Expanded]

By rspc

The Sarcophagus was never intended as a permanent solution. Rather, the concern at the time was to erect a structure which would confine the radioactive release as rapidly as possible. As a consequence, it never fit together seamlessly and, in any case, only had an estimated life of around 20 years - a time frame which has long since expired. In 1997 a plan funded by 46 different countries and organisations for a replacement - dubbed the New Safe Confinement (NSC) - was set in motion with an estimated cost of €2 billion. Construction began in 2011. Here you can see the first section being raised.



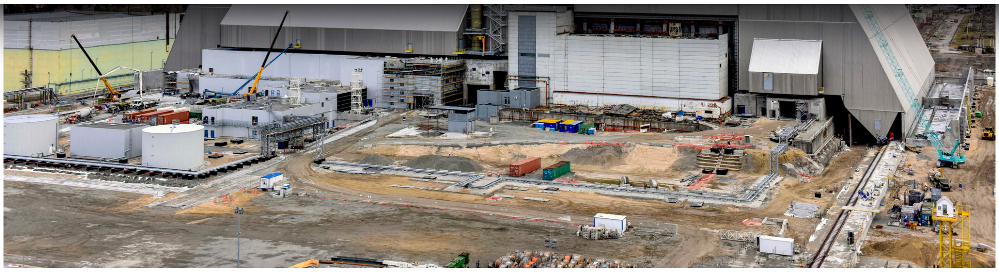
The enormous, one-of-a-kind arch, 250m wide by 165m long, existing Sarcophagus. It is be the largest movable structure ever built. Unlike the original Object Shelter, this new confinement has been built to last an estimated 100 years, by which time most of the decommissioning work on Unit 4 should be concluded. This image shows the NSC as was in April 2016.



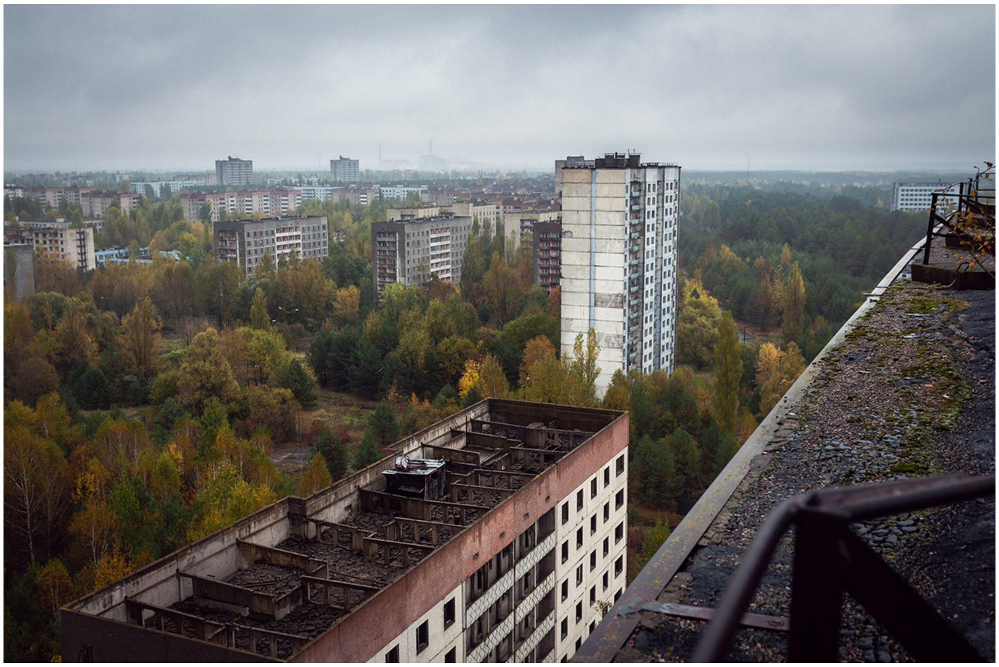
As part of this operation, Chernobyl's iconic chimney was removed in 2014 :(

The Chernobyl Story [Updated & Expanded]

By rspc



The New Safe Confinement was moved into position in November 2016. Here you can see the end of the turbine hall sticking out of the end in the lower-right of this picture.



Pripyat as it is now. I visited the city in 2011, and found it to be a profound experience. When I got back, I began to research and write a book both about the accident and my own journey there. The book came from my own frustration at the existing

The Chernobyl Story [Updated & Expanded]

By rspc

available from Amazon, titled "Chernobyl 01:23:40".

ТИЩУРА
АКИМОВ
АЛЕКСАНДР ФЕДОРОВИЧ
КИБЕНОК
ВИКТОР НИКОЛАЕВИЧ
17.II 1963 · 11.V 198
ПРАВИК
ВЛАДИМИР ПАВЛОВИЧ
13.VI 1962 · 11.V 1986

Someone lights a candle at the Chernobyl memorial in Slavutych, the town built to replace Pripyat. Akimov can be seen on the left. RIP.

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1 COMMENTS Expand All Best

Pasito2 the picture of the scientist with the elephants foot, i thought it would kill you if you were in the same room?

1 pts June 5

The Chernobyl Story [Updated & Expanded]

By rspc